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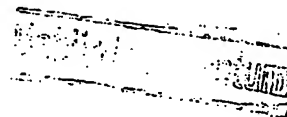


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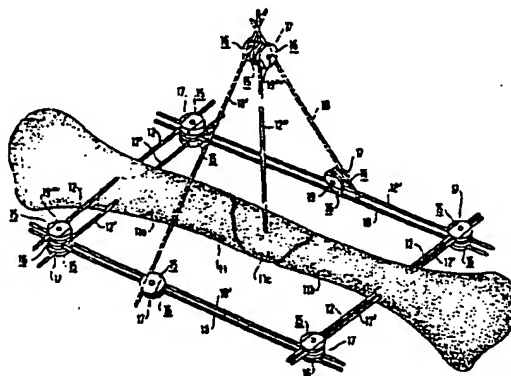
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⑤⑥ Für die Beurteilung der Patentfähigkeit
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DE	28 47 006 B1
DE	87 00 120 U1
FR	7 89 882
US	46 20 533
US	24 97 626

⑤④ Externe Knochenbruchteil-Verbindungsanordnung

Eine externe Knochenbruchteil-Verbindungsanordnung zur mechanischen Verbindung der Bruchteile (11a, 11b, 11c) eines gebrochenen Knochens (11) weist quer in die Bruchteile (11a, 11b, 11c) eingeführte Knochenhaltestangen (12, 12', 12'') auf, welche außerhalb des Knochens (11) zwischen zwei mit Nuten (13a, 13b) versehene Klemmböden (15a, 15b) klemmbar sind, welche gemeinsam das erste Drehglied (15) eines Gelenkes (17) bilden, dessen zweites Drehglied (16) mit Verbindungsstangen (18, 18') zur mechanischen Verbindung mehrerer Gelenke (17) versehen ist. Das zweite Drehglied (16) besteht aus zwei mit zu den Verbindungsstangen (18, 18') komplementären Nuten (14a, 14b) versehenen Klemmböden (16a, 16b).



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Beschreibung

Die Erfindung betrifft eine externe Knochenbruchteil-Verbindungsvorrichtung zur mechanischen Verbindung der Bruchteile eines gebrochenen Knochens, insbesondere des gebrochenen Unterschenkels, nach dem Oberbegriff des Patentanspruchs 1.

Bei einer bekannten derartigen externen Knochenbruchteil-Verbindungsvorrichtung (FR-A-7 89 882) sind die Verbindungsstangen in eine an einer Mantelseite offene, jedoch im wesentlichen geschlossene Bohrung des einen Drehgliedes eingeschoben und werden beim Verspannen der beiden Drehglieder gegen die eine Klemmbacke des anderen Drehgliedes gedrückt, wodurch gleichzeitig die Verbindungsstangen axial festgelegt werden und die beiden Drehglieder bei einer vorbestimmten Winkelstellung gegeneinander festgelegt werden.

Der Nachteil dieser bekannten Verbindungsvorrichtung besteht darin, daß die Verbindungsstangen axial in das ihnen zugeordnete Drehglied eingeführt werden müssen, was aus Platzgründen problematisch ist und wodurch es beispielsweise nicht möglich ist, ein Verbindungsstangen-Drehglied zwischen zwei bereits fest an der Verbindungsstange angeordneten Drehgliedern nachträglich anzubringen, ohne daß eines der beiden vorher schon vorhandenen festgeklebten Drehglieder entfernt wird. Hierdurch ist die Handhabung einer derartigen externen Knochenbruchteil-Verbindungsvorrichtung wesentlich erschwert, denn es kommt häufig vor, daß eine derartige, bereits am Knochen eines Patienten befestigte Verbindungsvorrichtung noch nachträglich durch weitere, an den Verbindungsstangen anzuordnende Drehglieder ergänzt werden soll. Man kann zwar zum Zwecke der nachträglichen Anbringung ein spezielles Drehglied zusätzlich vorsehen, was jedoch aufwendig ist und die Lagerhaltung kompliziert.

Der beschriebene Nachteil der vorbekannten Verbindungsvorrichtung ist in noch größerem Maße bei einer weiteren bekannten äußeren Spannvorrichtung für chirurgische Zwecke vorhanden (DE-A-28 47 006), denn hier müssen sowohl die Verbindungsstangen als auch die Knochenhaltestangen axial in die ihnen zugeordneten Drehglieder eingeführt werden.

Das Ziel der vorliegenden Erfindung besteht demgegenüber darin, eine externe Knochenbruchteil-Verbindungsvorrichtung der eingangs genannten Gattung zu schaffen, bei der an beliebigen Stellen sowohl der Knochenhaltestangen als auch der Verbindungsstangen insbesondere auch noch nachträglich einzelne oder miteinander in gewünschter Weise kombinierte Drehglieder angebracht werden können, ohne daß eventuell zuvor schon festgeklebte Drehglieder entfernt werden müssen.

Zur Lösung dieser Aufgabe sind die Merkmale des kennzeichnenden Teils des Patentanspruchs 1 vorgesehen.

Aufgrund dieser Ausbildung können die zunächst auseinandergenommenen Klemmbackenpaare an beliebigen Stellen von außen um die zugeordneten Knochenhaltestangen bzw. Verbindungsstangen herumgelegt und dann durch den zentralen Verbindungsbolzen miteinander und mit den eingelegten Stangen verspannt werden. Das erleichtert die Handhabung ganz erheblich und macht es möglich, nicht nur die für die Halterung der Knochenhaltestangen vorgesehenen Drehglieder, sondern auch die mit den Verbindungsstangen zu verklebenden Drehglieder an beliebigen Stellen der Ver-

bindungsstangen anzuordnen, und zwar selbst dann, wenn eine solche Anordnung zwischen zwei bereits im Abstand an den Verbindungsstangen befestigten Drehgliedern nachträglich erfolgen soll. Die erfindungsgemäße Knochenbruchteil-Verbindungsvorrichtung ist also in besonders universeller Weise einsetzbar und zu handhaben. Irgendwelcher spezieller zusätzlicher Drehglieder für nachträgliche Anbringung bedarf es nicht.

Da die erfindungsgemäß vorgesehenen Gelenke zumindest aus vier Klemmbacken zzgl. dem Verbindungsbolzen bestehen, ist die Ausführungsform nach Anspruch 2 bevorzugt, weil durch das ineinandergreifen der Klemmteile und Basisteile schon vor dem Hindurchstecken des Verbindungsbolzens durch die miteinander ausgerichteten Klemmbacken eine einwandfreie Relativposition der Klemmbacken in zwei Richtungen erzielt wird. Die Handhabung der Verbindungsvorrichtung wird also durch die Maßnahmen des Anspruchs 2 weiter erleichtert.

Durch die Merkmale des Anspruchs 3 wird erreicht, daß die miteinander durch ein Gelenk verbundenen Stangen in einer Ebene unter verschiedenen Winkeln zueinander eingestellt werden können.

Obwohl grundsätzlich auch eine Verspannung der Klemmbacken miteinander durch einen mit einer Mutter zusammenarbeitenden Verbindungsbolzen möglich ist, ist doch die Ausführungsform nach Anspruch 4 bevorzugt, weil durch die Anordnung der Gewindebohrung in der letzten Klemmbacke ein Einzelteil, nämlich die Mutter eingespart wird.

Ein besonderer Vorteil der Erfindung gegenüber dem eingangs abgehandelten Stand der Technik besteht darin, daß sowohl die Knochenhaltestangen als auch die Verbindungsstangen im gesamten Bereich der vorzugsweise halbzylinderförmigen Nuten an den Klemmbacken anliegen, so daß eine geringe Flächenbelastung und eine gleichmäßige Übertragung der Kräfte gewährleistet ist.

Besonders vorteilhaft ist die Ausführungsform nach Anspruch 5, weil hierdurch jeweils zwei zu einer ebenen Anordnung zusammengefaßte Knochenhaltestangen bzw. Verbindungsstangen an ein und demselben Drehglied angeordnet werden können, wodurch besonders stabile rahmenartige Gebilde geschaffen werden können.

Die Anordnung von zwei Verbindungsstangen parallel zueinander in ein und demselben Drehglied ermöglicht aber insbesondere die vorteilhafte Weiterbildung nach Anspruch 6 oder 7, mittels der die besonders vorteilhaften dynamischen Verbindungsvorrichtungen verwirklicht werden können, wie sie beispielsweise in der Zeitschrift "Akt. Traumatol. 17 (1987)", Seiten 86 bis 90 beschrieben sind. Bei derartigen dynamisierten Verbindungsvorrichtungen erstrecken sich die Knochenhaltestangen vorzugsweise senkrecht zur Knochenachse und liegen in ein und derselben Ebene. Zwei parallel zueinander angeordnete Verbindungsstangen verlaufen parallel zur Knochenachse und sind ebenfalls vorzugsweise in einer gemeinsamen Ebene angeordnet. Die Gelenke zwischen den Knochenhaltestangen und den Verbindungsstangen sind so ausgebildet, daß die eine Verbindungsstange jeweils in dem Gelenk des einen Knochenbruchteils und die andere Verbindungsstange in dem Gelenk des anderen Knochenbruchteils axial geführt gleiten kann. Hierdurch werden die beiden Bruchteile einerseits in exakter axialer Ausrichtung gehalten, während andererseits in Achsrichtung eine Verschiebung möglich ist. Dies hat den Sinn, bei der Belastung

des Bruches eine gewisse definierte Nachgiebigkeit der Verbindungsvorrichtung zu gewährleisten, wodurch der Knochenheilungsprozeß begünstigt wird.

Die vorteilhafte Weiterbildung der Erfindung nach den Patentansprüchen 6 und 7 ermöglicht auf einfache Weise eine dynamisierte Verbindungsvorrichtung in dem vorerwähnten Sinne. Beim Vorsehen von zwei im Abstand angeordneten Gelenken gleitet eine der Verbindungsstangen jeweils in dem einen ihr zugeordneten Nutzenpaar des einen Gelenks, nicht jedoch in dem zugeordneten Nutzenpaar des anderen Gelenks und umgekehrt.

Insbesondere aufgrund der Ausbildung nach Anspruch 7 braucht zur Verwirklichung einer Dynamisierung der Verbindungsvorrichtung lediglich eine zweite Sorte von Verbindungsstangen-Klemmbacken vorgesehen werden, wobei die eine Sorte eine kraftschlüssige Verklemmung beider Verbindungsstangen am Gelenk ermöglicht, die andere Sorte dagegen nur die Verklemmung der einen Verbindungsstange, während die andere Verbindungsstange streng axial geführt in dem Gelenk axial gleiten kann. Der Orthopäde oder Chirurg kann auf diese Weise wahlweise eine vollständige Fixierung oder eine im vorstehenden Sinne dynamisierte Fixierung der Bruchteile eines Knochens herbeiführen, wobei sich die Anbringungsmöglichkeit für die einzelnen Drehglieder an beliebigen Stellen der Verbindungsstangen besonders vorteilhaft auswirkt, denn es ist auf diese Weise beispielsweise möglich, eine beide Verbindungsstangen am Gelenk festklemmende Verbindungsstangen-Klemmbacke an Ort und Stelle problemlos durch eine andere Klemmbacke im Sinne der Ansprüche 6 oder 7 zu ersetzen, wenn dies beispielsweise im Verlauf des Knochenheilungsprozesses als vorteilhaft angesehen werden sollte. Dem Arzt stehen somit zwei verschiedene und einfach anzuwendende Möglichkeiten für die Fixierung eines Unterschenkelbruches zur Verfügung.

Die Verbindungsvorrichtung nach der vorerwähnten Zeitschrift "Akt. Traumatol. 17 (1987)" hat den Nachteil, daß die axiale Relativverschiebung der beiden Verbindungsstangen nur durch zusätzlich vorgesehene Anschläge begrenzt werden kann.

Die vorliegende Erfindung schafft ein System, bei dem einfach ein Verbindungsstangen-Klemmbackenpaar als Anschlag im Sinne des Anspruches 8 verwendet werden kann, ohne daß — mit Ausnahme eines kürzeren Verbindungsbolzens — irgendwelche Anpassungsmaßnahmen erforderlich sind.

Zur Herbeiführung einer einwandfreien Drehfixierung der relativ zueinander verdrehbaren Drehglieder eines Gelenkes ist die Maßnahme nach Anspruch 9 vorteilhaft, denn die Radialverzahnung gewährleistet zum einen die Aufrechterhaltung einer einmal eingestellten Winkelposition bis zum Festziehen des Verbindungsbolzens, während zum anderen eine Weiterstellung der Drehglieder um definierte vorbestimmte Winkelbereiche ermöglicht wird. Eine ausreichende Feineinstellung der Drehglieder relativ zueinander wird ermöglicht, wenn der einzelne Zahn der Radialverzahnung einen Winkel von 2 bis 5°, insbesondere etwa 3° einnimmt. Dies bedeutet z.B., daß über den Umfang verteilt 120 Zähne zusammen die Ringverzahnung bilden.

Durch die Distanzscheiben nach Anspruch 10, die in unterschiedlichen Dicken vorhanden sein können, werden weitere Anpassungsmöglichkeiten an unterschiedliche orthopädische Raumverhältnisse ermöglicht.

Die bauliche Ausbildung der erfindungsgemäßen

Verbindungsvorrichtung erfolgt zweckmäßigerweise gemäß den Ansprüchen 11 bis 14, denn hierdurch wird zum einen ein kompakter Aufbau der Gesamtanordnung erzielt, während zum anderen die Einzelteile beispielsweise auch problemlos in um 180° versetzter Position verwendet werden können, ohne daß es dabei zu Passungsschwierigkeiten kommt.

Die Erfindung wird im folgenden beispielsweise anhand der Zeichnung beschrieben; in dieser zeigt:

Fig. 1 einen axialen Querschnitt eines bei der erfindungsgemäßen Verbindungsvorrichtung vorgesehenen Gelenks,

Fig. 2 eine Draufsicht des Gelenks nach Fig. 1 in Richtung des Pfeiles II in Fig. 1,

Fig. 3 eine teilweise aufgebrochene Draufsicht des Gelenkes nach Fig. 1 in Richtung des Pfeiles III in Fig. 1,

Fig. 4 eine Draufsicht einer an einem Knochenbruch angeordneten erfindungsgemäßen Verbindungsvorrichtung bei einseitig offener im wesentlichen ebener Rahmenanordnung,

Fig. 5 eine Ansicht des Gegenstandes der Fig. 4 in Richtung des Pfeiles V in Fig. 4,

Fig. 6 eine zu Fig. 4 ähnliche Ansicht mit einer anderen Anordnung der Anschläge,

Fig. 7 eine Ansicht des Gegenstandes der Fig. 6 in Richtung des Pfeiles VII in Fig. 6,

Fig. 8 eine zu den Fig. 4 und 6 ähnliche Ansicht mit einer weiteren möglichen Anordnung der Anschläge,

Fig. 9 eine Ansicht des Gegenstandes der Fig. 8 in Richtung des Pfeiles IX in Fig. 8,

Fig. 10 eine ähnliche Ausschnittsansicht wie die Fig. 5, 7 und 9, wobei jedoch zusätzlich noch eine Distanzscheibe vorgesehen ist und

Fig. 11 eine schematische perspektivische Ansicht einer dreidimensionalen, zeltartigen Verbindungsvorrichtung gemäß der Erfindung.

Nach den Fig. 1 bis 3 bestehen die Gelenke 17 einer erfindungsgemäßen externen Knochenbruchteil-Verbindungsvorrichtung jeweils aus zwei im wesentlichen kreiszylindrischen und miteinander kongruenten Drehgliedern 15, 16, die an ihren einander zugewandten Stirnflächen jeweils gleich ausgebildete Radialverzahnungen 24 aufweisen, welche konzentrisch zur Mittelachse 26 der Drehglieder 15, 16 verlaufen.

In der Mitte der in etwa scheibenförmig ausgebildeten Drehglieder 15, 16 befinden sich zentrale Verbindungsbohrungen 20 bzw. 20', wobei die Bohrung 20' einen etwas geringeren Durchmesser als die Verbindungsbohrungen 20 aufweist und mit einem Innengewinde 27 versehen ist. Von der freien Stirnseite des Drehgliedes 15 ist ein mit einem Kopf versehener Verbindungsbolzen 19 durch die Verbindungsbohrungen 20 hindurchgesteckt und in die am gegenüberliegenden Ende vorgesehene mit Innengewinde 27 versehene Bohrung 20' eingeschraubt, wobei sich der Kopf des Verbindungsbolzens 19 in eine dazu komplementäre Vertiefung 28 des Drehgliedes 15 setzt und so die beiden Drehglieder 15, 16 axial miteinander verspannt und auch axial ausrichtet.

Bei etwas gelöstem Verbindungsbolzen 19 können die beiden Drehglieder 15, 16 um die Mittelachse 26 verdreht werden, wobei die Rastverzahnungen 24 jeweils von einem Zahn zum nächsten springen. Durch erneutes Festziehen des Verbindungsbolzens 19 kann die einmal eingestellte Winkellage fixiert werden.

Erfindungsgemäß bestehen die Drehglieder 15, 16 jeweils aus zwei Klemmbacken 15a, 15b bzw. 16a, 16b, von denen die aneinanderliegenden Klemmbacken 15a bzw.

16a, die mit den Radialverzahnungen 24 versehen sind, ein in der Ansicht der Fig. 1 im wesentlichen U-förmiges Basisteil bilden, welches auf der von der Radialverzahnung 24 abgewandten Stirnfläche mit im wesentlichen halbkreisförmig ausgebildeten Nuten 13a bzw. 14a versehen sind.

In die voneinander abgewandten Öffnungen der mit einem im wesentlichen U-förmigen Querschnitt versehenen, als Basisteile ausgebildeten Klemmböcken 15a bzw. 15b sind Klemmenteile bildende zweite Klemmböcken 15b bzw. 16b eingesetzt, welche die aus den Fig. 2 und 3 ersichtliche abgeflachte Kreisform aufweisen. Die Klemmböcken 15b, 16b weisen im wesentlichen ebene äußere Stirnflächen auf und sind axial gegenüber den Nuten 13a, 14a mit ebenfalls annähernd halbkreisförmig ausgebildeten und parallel zu den Nuten 13a, 14a verlaufenden Nuten 13b bzw. 14b versehen, wodurch insgesamt die aus Fig. 1 ersichtlichen kreiszylindrischen Klemmkannäle mit den Längsachsen 21 bzw. 22 gebildet werden. Die Verbindungsbohrungen 20, 20' sind durch entsprechende Bohrungen in den Klemmböcken 15a, 15b, 16a, 16b verwirklicht, wobei die Verbindungsbohrungen 20 in den Klemmböcken 15a, 15b, 16a und die Gewindebohrung 20' in der letzten Klemmböcke 16b vorgesehen sind.

Der untere linke kreiszylindrische Klemmkanal mit der Längsachse 22 kann auch mit einer etwas größeren Gleitnut 14a' in der Klemmböcke 16a versehen sein, deren Sinn und Zweck weiter unten im einzelnen beschrieben wird.

Die durch die Nuten 13a, 13b gebildeten kreiszylindrischen Klemmkannäle, welche ebenso wie die durch die Nuten 14a, 14b gebildeten Klemmkannäle mit ihrer Längsachse 21 senkrecht zur Mittelachse 26 der Drehglieder 15, 16 verlaufen, dienen nach den Fig. 4 und 5 zur Aufnahme und Klemmung von zwei parallel zueinander und in einer Ebene angeordneten Knochenhaltestangen 12, 12', die in die beiden Bruchteile 11a, 11b eines Knochens 11 eingeschraubt sind, und zwar im wesentlichen senkrecht zur Längsachse des Knochens 11.

Die durch die Nuten 14a, 14b gebildeten kreiszylindrischen Klemmkannäle mit den Längsachsen 22 weisen einen deutlich größeren Durchmesser als die durch die Nuten 13a, 13b gebildeten Klemmkannäle auf und dienen zur im wesentlichen formschlüssigen Aufnahme von zwei parallel zueinander angeordneten entsprechend kreiszylinderförmigen Verbindungsstangen 18, 18' (Fig. 4, 5). Durch Anziehen des Verbindungsbolzens 19 (Fig. 1, 4, 5) kann die Position der Knochenhaltestange 12, 12' und der Verbindungsstangen 18, 18' gemäß den Fig. 4, 5 festgelegt werden.

Wird die Ausführungsform mit der etwas größeren Gleitnut 14a' (Fig. 1) verwendet, so ist es erforderlich, daß die beiden Klemmböcken 16a, 16b sich im Bereich der Gleitnut 14a' nicht nur auf den Verbindungsstangen 18, 18', sondern auch unmittelbar an einer Verbindungsstelle 23 aneinander abstützen, und zwar derart, daß die Verbindungsstange 18 oder 18' an der betreffenden Stelle zwar formschlüssig und axial geführt gehalten, nicht jedoch axial unverschieblich festgeklemmt wird.

In den Fig. 4 und 5 ist die axialverschiebbliche Lagerung der Verbindungsstangen 18 bzw. 18' in den Drehgliedern 16 durch eine Rauhschattierung und die Bezugzahl 14a' angedeutet. Nach Fig. 4 ist also bei dem rechten Gelenk 17 die obere Verbindungsstange 18, beim linken Gelenk 17 die untere Verbindungsstange 18' axial verschiebbar im zugeordneten Drehteil 16 gelagert, während die jeweils andere Verbindungsstange

in dem betreffenden Gelenk 17 vollständig festgeklemmt ist. Auf diese Weise können die beiden Gelenke 17 in Richtung des Doppelpfeiles in Fig. 4 relativ zueinander verschoben werden. Um die axiale Verschiebung der beiden Gelenke 17 nach den Fig. 4 und 5 in Richtung des Doppelpfeiles zu begrenzen, sind links neben den Gelenken 17 separate Drehglieder 16 mittels verkürzter Verbindungsbolzen 19' auf den Verbindungsstangen 18, 18' angeordnet, wobei ein definierter geringer Abstand a zu den Drehgliedern 16 der Gelenke 17 eingestellt ist. Die Summe der beiden Abstände a ergibt den Gesamtverschiebungsbereich der Gelenke 17 in Richtung des Doppelpfeiles relativ zueinander.

Damit die zusätzlichen Drehglieder 16 als Anschläge wirken können, müssen dort die Gleitnuten 14a' gerade in umgekehrter Anordnung wie bei den zugeordneten Gelenken 17 vorgesehen werden.

Die Anordnung der Gewindebohrung 20' (Fig. 1) in der äußeren Klemmböcke 16b des Verbindungsstangen-Drehgliedes 16 hat also auch den Zweck, die separate Benutzung der Drehglieder 16 als Anschläge im Sinne von Fig. 4, 5 mit verkürzten Verbindungsbolzen 19' zu ermöglichen.

Die Handhabung der erfindungsgemäßen Verbindungsanordnung ist wie folgt:

Zunächst werden die Knochenhaltestangen 12, 12' gemäß den Fig. 4, 5 möglichst senkrecht zur Achse des Knochens 11 in die Bruchteile 11a, 11b eingeschraubt. Als dann werden die Gelenke 17 mit den Verbindungsstangen 18, 18' angebracht, und die gewünschte Relativlage der beiden Bruchteile 11a, 11b wird dann durch Beobachtung eines Röntgenbildes der Bruchstelle eingestellt und durch Festziehen der Verbindungsbolzen 19 fixiert.

Soll eine Dynamisierung erreicht werden, ist es auch möglich, daß an den Gelenken 17 von vornherein Klemmböcken 16b mit Gleitnut 14a' in der aus Fig. 4 und 5 ersichtlichen Anordnung vorgesehen werden, wobei dann die am Beginn des Heilungsprozesses zweckmäßige vollständige Fixierung des Bruches auch dadurch verwirklicht werden kann, daß der Abstand a in Fig. 4 durch entsprechende Verschiebung der als Anschläge wirkenden Drehglieder 16 zu Null gemacht wird.

Eine derartige Ausbildung ist in den Fig. 6 und 7 dargestellt, wobei das in Fig. 4 linke, als Anschlag wirkende separate Drehglied 16 jedoch rechts von dem Gelenk 17 angebracht ist, was ebenfalls möglich ist.

Die Fig. 8 und 9 zeigen eine andere mögliche Anordnung der als Anschläge wirkenden separaten Drehglieder gegenüber Fig. 4, wobei nunmehr das rechte, als Anschlag wirkende Drehglied 16 rechts vom Gelenk 17 angeordnet ist. Der Abstand a ist auch bei dem Ausführungsbeispiel nach den Fig. 8 und 9 zu Null gemacht worden, kann jedoch durch problemlose axiale Verschiebung der separaten Drehglieder 16 vom Arzt jederzeit wiederhergestellt werden.

Fig. 10 zeigt, daß zwischen zwei Drehgliedern 15, 16 auch noch eine entsprechend dimensionierte Distanzscheibe 25 angeordnet werden kann, welche zweckmäßigerweise an beiden Stirnseiten die Radialverzahnungen 24 aufweist, mittels deren sie bei Verspannung durch den Verbindungsbolzen 19' die beiden Drehglieder 15, 16 drehfest miteinander verspannen kann. Die Distanzscheiben 25 können in unterschiedlichen Dicken vorrätig gehalten werden, wobei der Verbindungsbolzen 19' entsprechend länger als beim Ausführungsbeispiel nach den Fig. 1 bis 3 auszubilden ist.

Durch entsprechend mit unterschiedlicher Länge ausgebildete Verbindungsbolzen und in verschiedener Weise miteinander kombinierte Drehglieder 15, 16 bzw. Distanzscheiben 25 können auch räumlich komplizierte Verbindungsvorrichtungen verwirklicht werden, wobei ein Beispiel in Fig. 11 perspektivisch dargestellt ist.

Die Knochenstangen 12, 12' durchgreifen zum Teil in verschiedenen Höhen die Bruchteile 11a, 11b des Knochens 11 vollständig und münden auf entgegengesetzten Seiten des Knochens 11 jeweils in Drehgliedern 15, wo sie erfindungsgemäß festgeklemmt sind. Die einzelnen Drehglieder 15 auf den entgegengesetzten Seiten des Knochens 11 sind mittels der Drehglieder 16 und der Verbindungsstangen 18, 18' miteinander verbunden, wobei ggfs. eine Dynamisierung gemäß den Fig. 4, 5 vorgesehen sein könnte.

Da die in Fig. 11 linken Knochenhaltestangen 12, 12' in der Höhe versetzt sind, sind auf beiden Seiten eines mittleren Drehgliedes 16 zwei Knochenstangenhalter-Drehglieder 15 angeordnet, wozu ein entsprechend lang ausgebildeter Verbindungsbolzen 19''' zu verwenden ist. Entsprechend ist die Ausbildung des gegenüberliegenden Gelenks 17.

Der Knochen 11 weist bei dem Ausführungsbeispiel nach Fig. 11 in der Mitte ein herausgebrochenes Stück 11c auf, welches durch eine zeltstangenartig von oben eingebohrte Knochenhaltestange 12'' relativ zu den Bruchteilen 11a, 11b fixiert werden kann, wobei die Halterung der Knochenhaltestange 12'' durch zeltartig aufgestellte Verbindungsstangen 18, 18' erfolgt, die über zwei beidseits eines mittleren Drehgliedes 15 vorgesehene Verbindungsstangen-Drehglieder 16 in der dargestellten Position fixiert werden. Die Verbindung mit dem in der Ebene des Knochens 11 befindlichen Rahmen erfolgt über jeweils zwei miteinander zusammengebaute Verbindungsstangen-Drehglieder 16.

Aus dem Ausführungsbeispiel nach Fig. 11 ergibt sich, daß die Verbindungsstangen-Drehglieder 16 nicht nur gemäß den Fig. 4 bis 9 allein als Anschläge, sondern auch paarweise zur Verbindung von Verbindungsstangen unter verschiedenen Winkeln verwendet werden können. Nimmt man noch die Distanzscheiben 25 gemäß Fig. 10 als weiteres Bauelement hinzu, so können mit der erfindungsgemäßen Verbindungsanordnung auch komplizierte räumliche Verbindungsvorrichtungen in gewünschter Weise verwirklicht werden.

Die beiden Klemmbacken 16a, 16b der Verbindungsstangen-Drehglieder 16 sind zwar bevorzugt gemäß Fig. 1 als ineinandergeschachtelte Bauteile ausgebildet, doch könnten grundsätzlich auch zwei vollständig zur Berührungsebene zueinander symmetrische Klemmbacken verwendet werden.

Patentansprüche

1. Externe Knochenbruchteil-Verbindungsvorrichtung zur mechanischen Verbindung der Bruchteile (11a, 11c) eines gebrochenen Knochens (11), insbesondere des gebrochenen Unterschenkels, mit quer in die Bruchteile (11a, 11b, 11c) eingeführten Knochenhaltestangen (12, 12', 12''), welche außerhalb des Knochens (11) und des ihn enthaltenden Gliedes zwischen zwei mit zu den Knochenhaltestangen (12, 12', 12'') komplementären, gegenüberliegenden Nuten (13a, 13b) versehene Klemmbacken (15a, 15b) klemmbar sind, welche gemeinsam das erste Drehglied (15) eines Gelenkes (17) bilden, dessen zweites Drehglied (16) durch einen Verbindungs-

bolzen (19) gegenüber dem ersten Drehglied (15) in verschiedenen Winkelpositionen festlegbar und mit Verbindungsstangen (18, 18') zur mechanischen Verbindung mehrerer Gelenke (17) versehen ist, dadurch gekennzeichnet, daß das zweite Drehglied (16) aus zwei mit zu den Verbindungsstangen (18, 18') komplementären Nuten (14a, 14b) versehenen Klemmbacken (16a, 16b) besteht.

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Klemmbacken (15a, 15b; 16a, 16b) aus einem im Querschnitt U-förmigen Basisteil (15a, 16a) und einem dazu komplementären, in die Öffnung des U vorzugsweise formschlüssig einsetzbaren Klemmteil (15b, 16b) bestehen, wobei die Nuten (13a, 14a; 13b, 14b) sich am Boden des U bzw. der gegenüberliegenden Fläche des Klemmteils (15b, 16b) befinden.

3. Vorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Verbindungsbolzen (19) bzw. die für ihn vorgesehenen Bohrungen (20, 20') senkrecht zu den Längsachsen (21, 22) der Nuten (13a, 13b; 14a, 14b) verlaufen.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Verbindungsbolzen (19) durch eine Verbindungsbohrung (20) in den Klemmbacken (15a, 15b; 16a, 16b) in eine Gewindebohrung (20') der vom Kopf des Verbindungsbolzens (19) aus gesehen letzten Klemmbacke (16b) eingeschraubt ist.

5. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Verbindungsstangen-Klemmbacken (16a, 16b) und vorzugsweise auch die Knochenhaltestangen-Klemmbacken (15a, 15b) jeweils zwei beidseitig der Verbindungsbohrung (20, 20') vorgesehene Nutenpaare (13a, 13b; 14a, 14b) aufweisen.

6. Vorrichtung nach Anspruch 5, dadurch gekennzeichnet, daß wenigstens eine Klemmbacke (16a) der Verbindungsstangen-Klemmbackenpaare (16a, 16b) eine derart vergrößerte Gleitnut (14a') aufweist und sich neben der betreffenden Nut (14a') auch unmittelbar (23) derart an der anderen Klemmbacke (16b) abstützt, daß die in diese Gleitnut (14a') und die entsprechende Gegennut (14b) eingesetzte Verbindungsstange (18, 18') bei festgeschraubtem Verbindungsbolzen (19) axial geführt in dem Drehglied (16) verschiebbar ist.

7. Vorrichtung nach Anspruch 6, dadurch gekennzeichnet, daß nur eine der Klemmbacken (16a) der Verbindungsstangen-Klemmbackenpaare (16a, 16b) in der beschriebenen Weise ausgebildet ist.

8. Vorrichtung nach Anspruch 6 oder 7, dadurch gekennzeichnet, daß als Anschläge neben den Gelenken (17) reine Verbindungsstangen-Klemmbackenpaare (16a, 16b) anbringbar sind, welche wenigstens eine Gleitnut (14a') an derjenigen Verbindungsstange (18') aufweisen, mit der das zugeordnete Gelenk (17) fest verklemmt ist.

9. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Drehglieder (15, 16) auf den aneinanderliegenden Flächen eine zur Verbindungsbohrung (20, 20') konzentrische und miteinander in Eingriff stehenden Radialverzahnungen (24) aufweisen.

10. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß Distanzscheiben (25) vorgesehen sind, die eine Verbindungsbohrung (20') für den Verbindungsbolzen

(19) aufweisen und an beiden Stirnflächen komplementär zu den einander zugewandten Flächen der Drehglieder (15, 16) ausgebildet sind.

11. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Drehglieder (15, 16) und vorzugsweise auch die Distanzscheibe kreiszylindrisch ausgebildet sind. 5

12. Vorrichtung nach Anspruch 11, dadurch gekennzeichnet, daß die Durchmesser der Drehglieder (15, 16) und ggfs. auch der Distanzscheibe (25) 10 gleich groß sind.

13. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Nutenpaare (13a, 13b; 14a, 14b) eines Drehgliedes (15; 16) parallel zueinander angeordnet sind. 15

14. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Nutenpaare (13a, 14b; 14a, 14b) eines Drehgliedes (15; 16) im gleichen Abstand von der Mittelachse (26) der Verbindungsbohrungen (16, 16') angeordnet 20 sind.

Hierzu 7 Seite(n) Zeichnungen

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Fig. 1

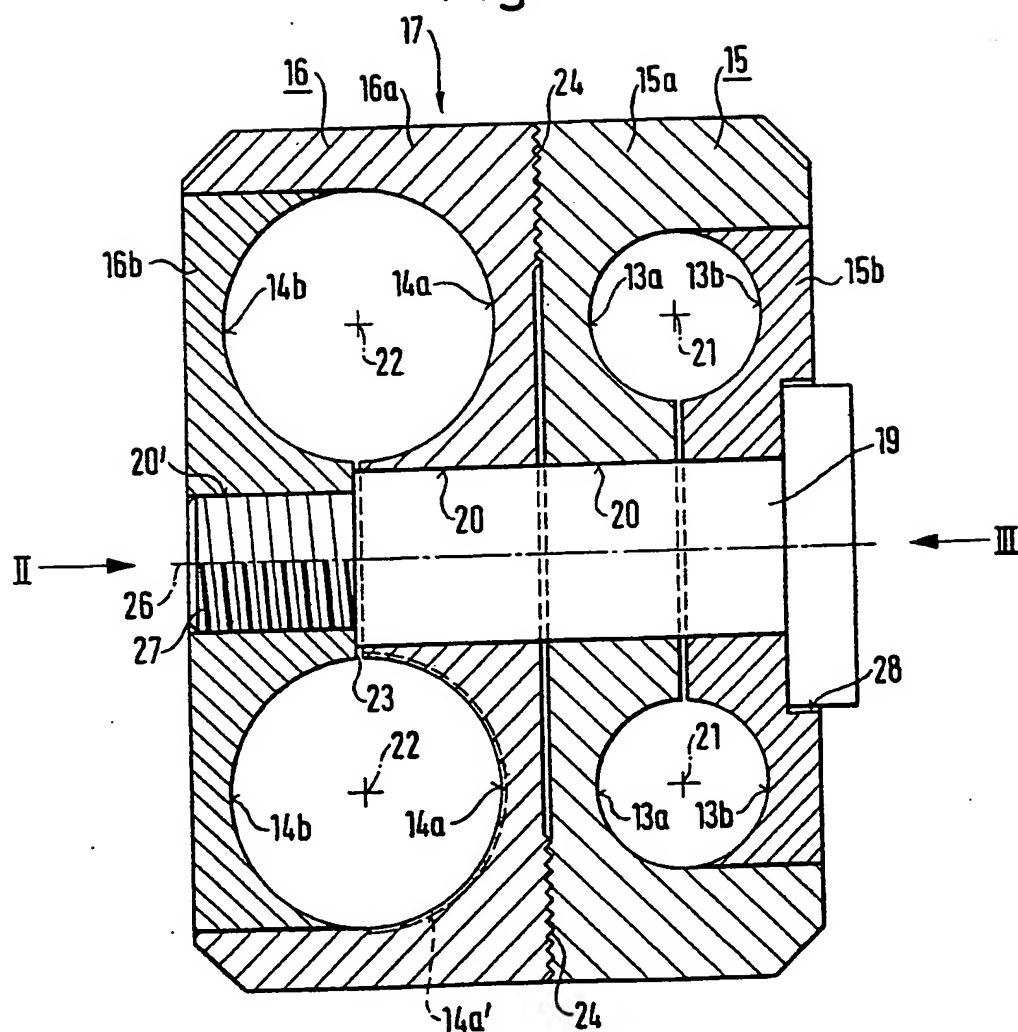


Fig. 2

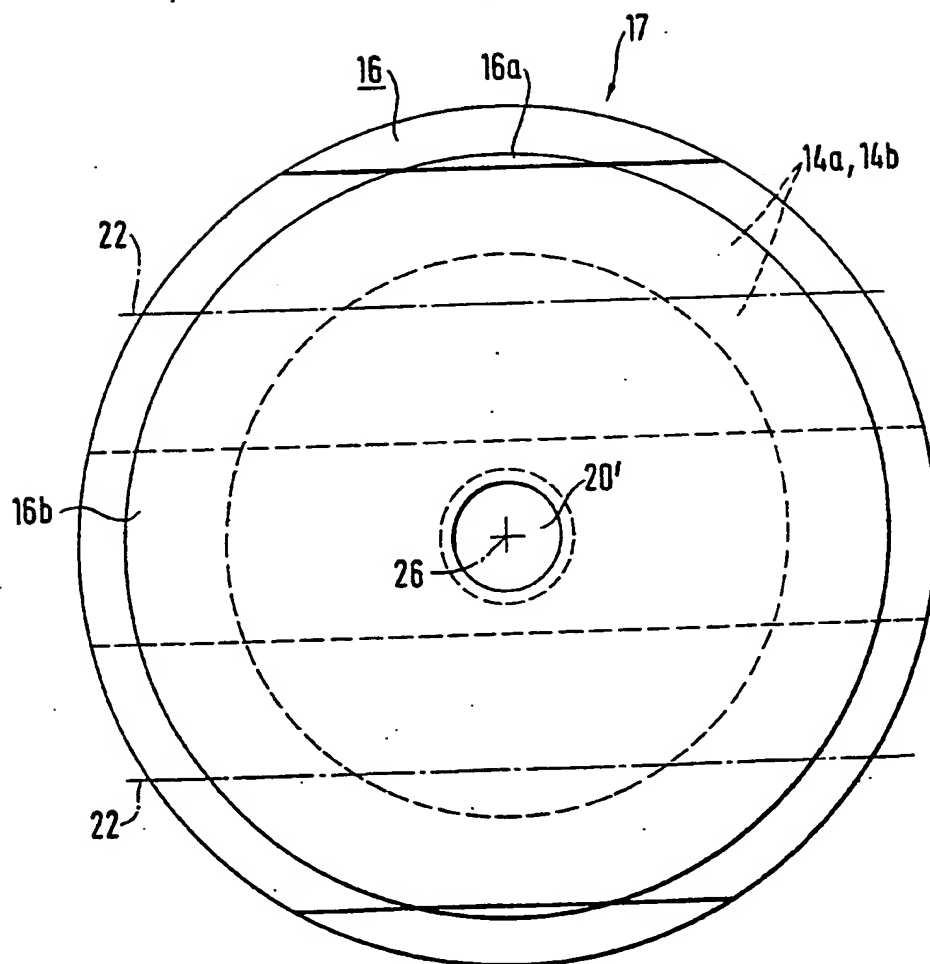


Fig. 3

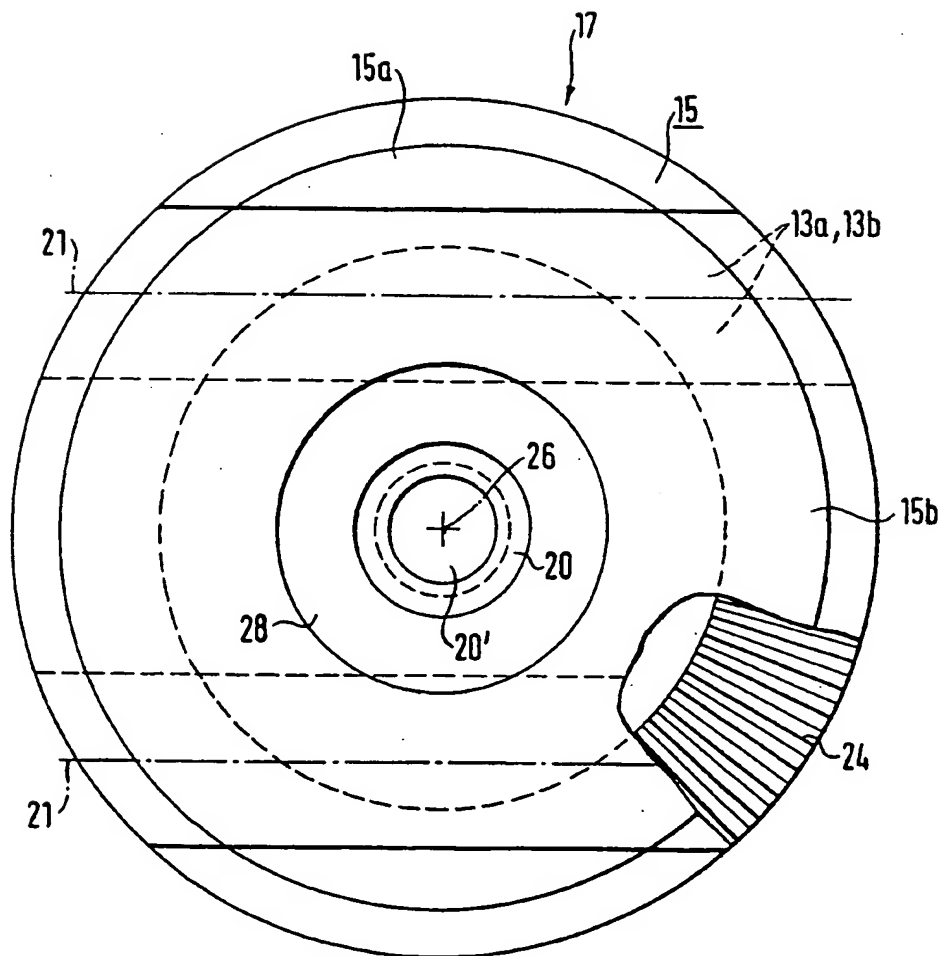


Fig. 4

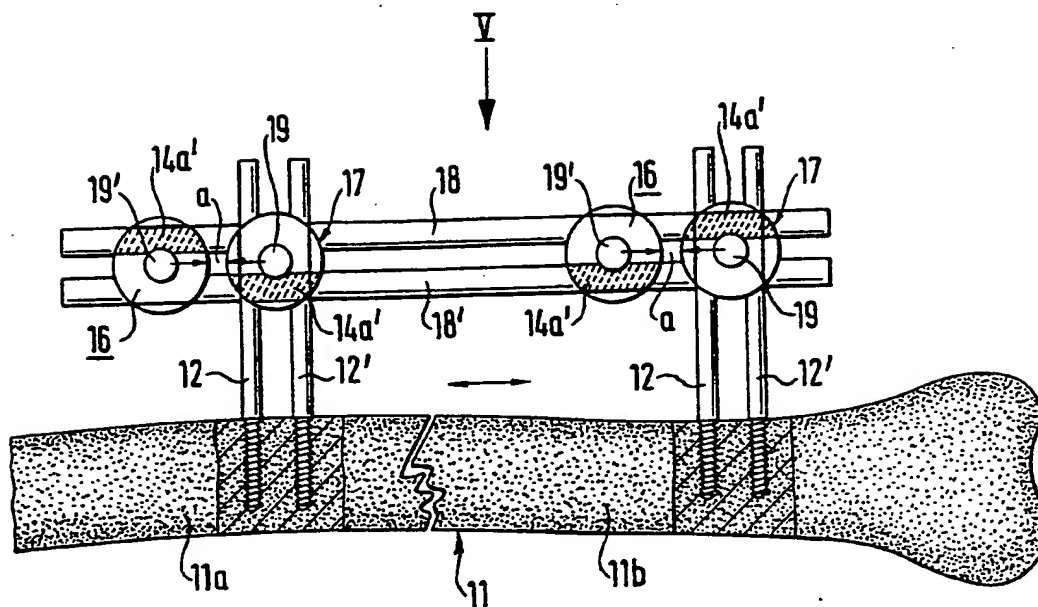


Fig. 5

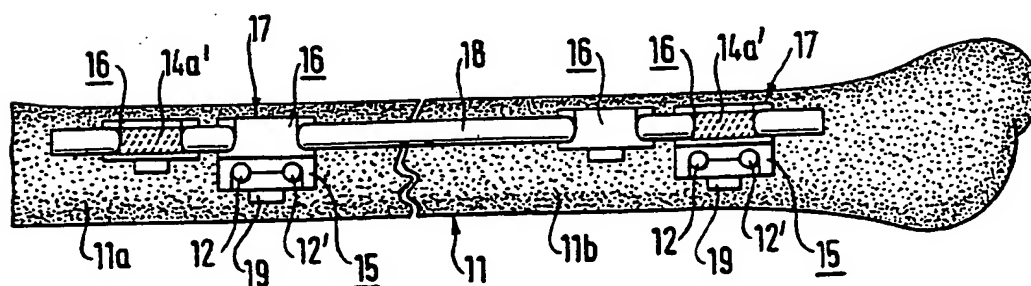


Fig. 6

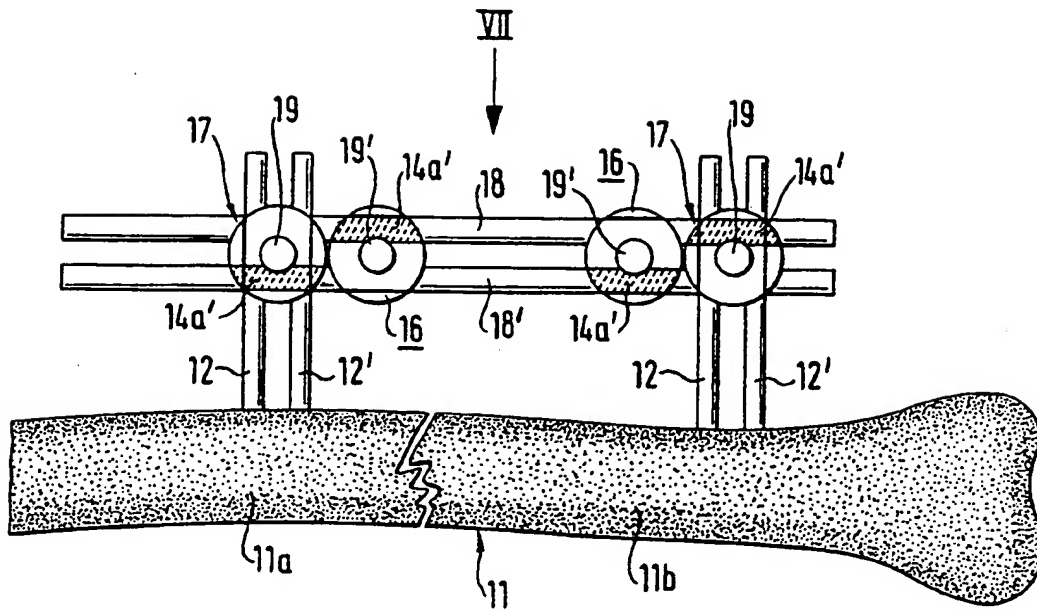


Fig. 7

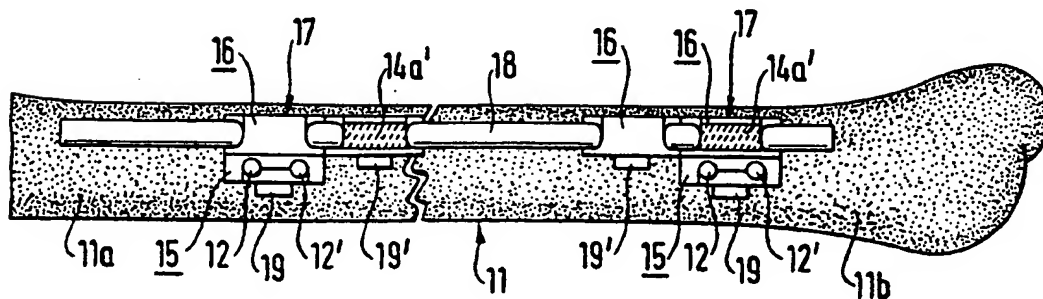


Fig. 8

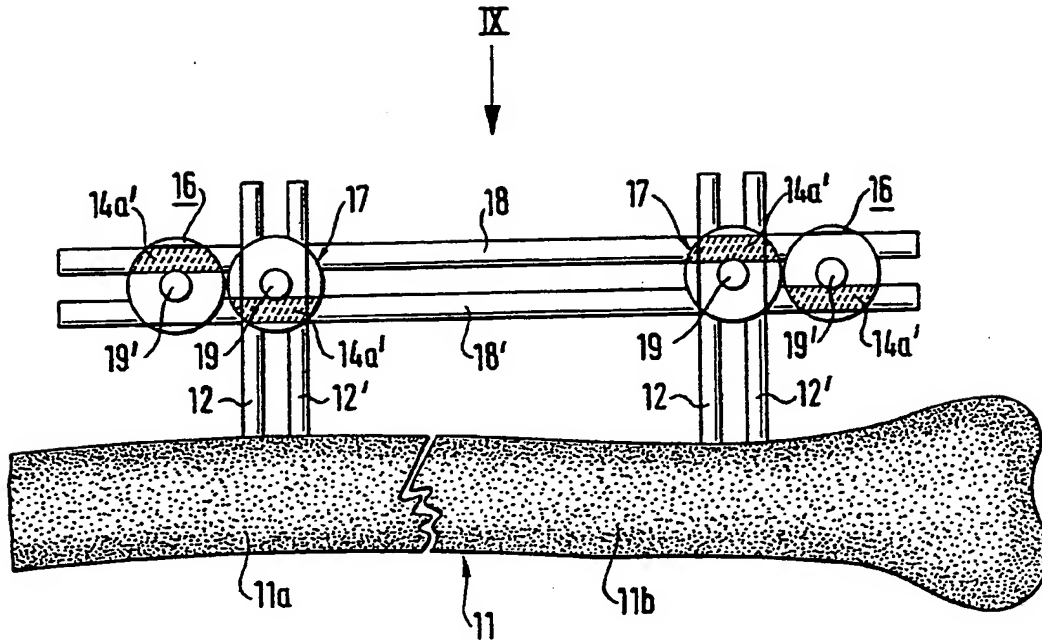
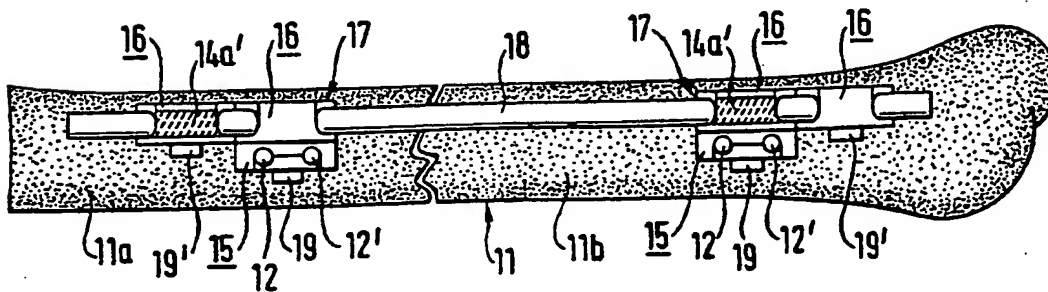
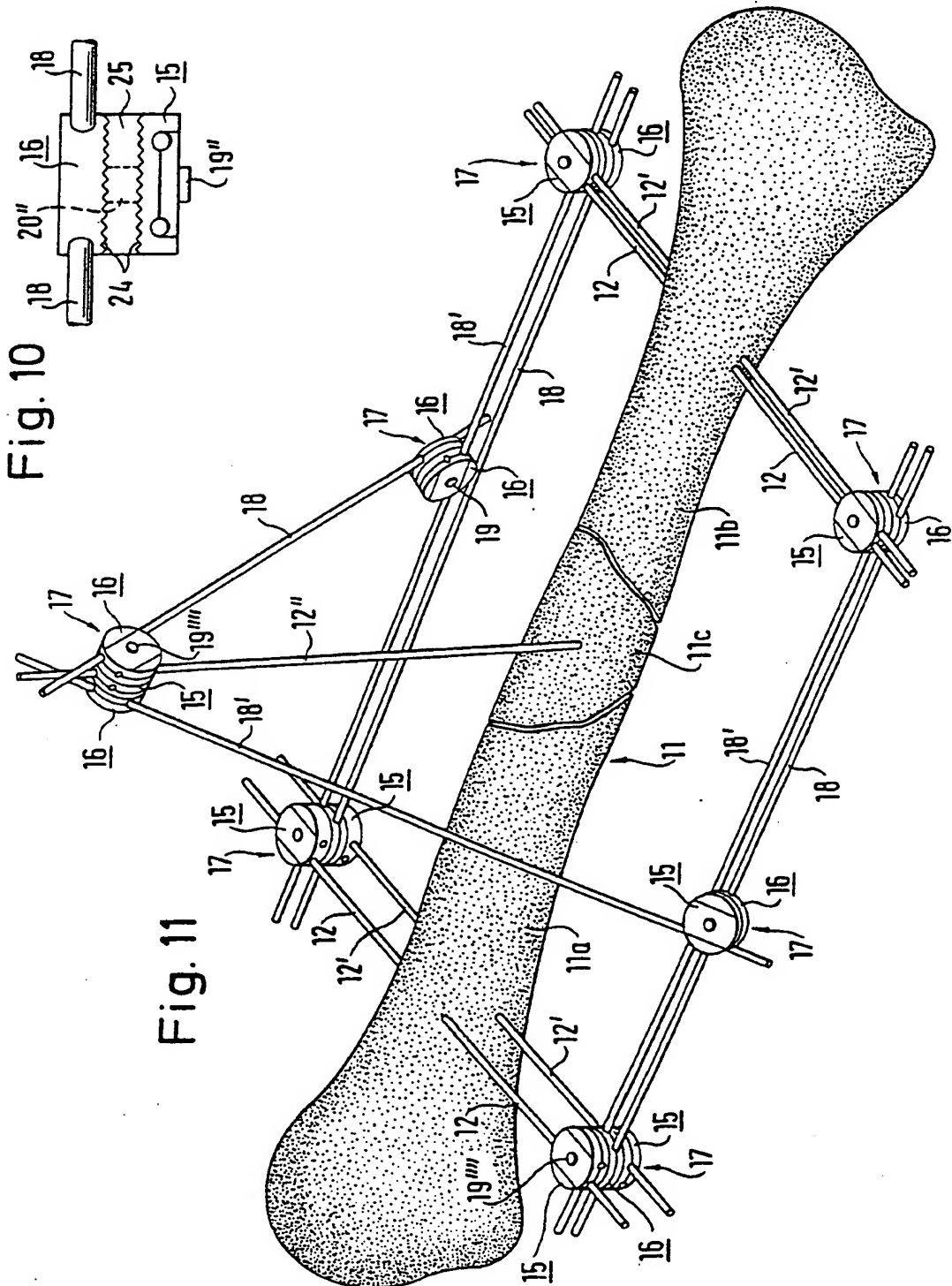


Fig. 9





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(54) External Bone Fragment Connecting Device

An external bone fragment connecting device for the mechanical connection of the fragments (11a, 11b, 11c) of a broken bone (11) has bone holding rods (12, 12', 12'') inserted transversely into the fragments (11a, 11b, 11c), which are clampable between two clamp jaws (15a, 15b) provided with grooves (13a, 13b), which together form the first rotating member (15) of a joint (17), whose second rotating member (16) is provided with connecting rods (18, 18') for the mechanical connection of a plurality of joints (17). The second rotating member (16) consists of two clamp jaws (16a, 16b) provided with grooves (14a, 14b) complementary to the connecting rods (18, 18').

Description

The invention concerns an external bone fragment connecting arrangement for the mechanical connection of the fragments of a broken bone, in particular of the broken lower leg, according to the generic portion of claim 1.

In a known external bone fragment connecting arrangement of this type (FR-A-7 89 882), the connecting rods are inserted into a bore in one of the rotating members open on one casing side yet substantially closed and are pressed upon bracing of the two rotating members against one of the clamp jaws of the other rotating member, whereby simultaneously the connecting rods are axially fixed and the two rotating members are fixed at a predefined angular position relative to each other.

The disadvantage of this known connecting arrangement consists in that the connecting rods must be introduced axially into the rotating member associated therewith, which is problem for reasons of space and whereby it is, for example, not possible to install a connecting rod-rotating member between two rotating members already fixed on the connecting rod, without removing one of the two clamped rotating members already present. This makes the manipulation of such an external bone fragment connecting arrangement significantly more difficult, for it frequently occurs that such a connection arrangement already fixed on the bone of a patient should be subsequently supplemented by additional rotating members to be arranged on the connecting rods. It is, to be sure, possible to provide a special rotating member for the purpose of subsequent installation, an approach which is, however, expensive and complicates inventory management.

The described disadvantage of the prior art connecting arrangement is present to an even greater extent in another known external fixation arrangement for surgical purposes (DE-A-28 47 006), for in this case, both the connecting rods and the bone holding rods must be inserted axially into the rotating member associated therewith.

In contrast, the object of the present invention is, consequently, to provide an external bone fragment connecting arrangement of the type mentioned in the introduction, whereby both the bone holding rods and the connecting rods, and even rotating members, in particular, can be installed at any location after the fact individually or combined with each other as desired, without any rotating members previously already clamped in place having to be removed.

To accomplish this object, the characteristics of the characterizing portion of claims 1 are provided.

Based on this design, the individually disassembled pairs of clamping jaws can be placed externally at any locations around the bone holding rods or connecting rods and then braced with each other and with the rods installed by the central connecting bolt. This very significantly simplifies manipulation and makes it possible to arrange not only the rotating members provided to hold the bone holding rods, but also the rotating members to be clamped to the connecting rods at any locations on the connecting rods, even when

such an arrangement must be made after the fact between two rotating members already attached at a distance from each other on the connecting rods. The bone fragment connecting arrangement according to the invention is thus particularly universally usable and manipulatable.

Since the joints provided according to the invention consist of at least four clamp jaws plus the connecting bolt, the embodiment according to claim 2 is preferred, since problem-free relative positioning of the clamp jaws in two directions is obtained by means of the engagement of the clamp parts and base parts in each other even before insertion of the connecting bolt through the clamp jaws aligned with each other. The manipulation of the connection arrangement is thus rendered even easier by the measures of claim 2.

By means of the characteristics of claim 3, the rods connected to each other in one plane by a joint can be adjusted at different angles relative to each other.

Although, in principle, even bracing of the clamp jaws against each other by means of a connecting bolt working in conjunction with a nut is possible, the embodiment according to claim 4 is, however, preferred since a separate part, i.e., the nut, is avoided by the arrangement of the threaded bore in the last clamp jaw.

A particular advantage of the invention compared to the prior art mentioned in the introduction consists in that both the bone holding rods and the connecting rods are in contact with the clamp jaws in the entire zone of the preferably half-cylindrical grooves such that a low surface load and a uniform transmission of forces is guaranteed.

The embodiment according to claim 5 is particularly advantageous since with it two bone holding rods or connecting rods combined into a flat arrangement can be arranged on one and the same rotating member, by which means particularly stable frame structures can be created.

The arrangement of two connecting rods parallel to each other in one and the same rotating member enables, however, in particular, the advantageous improvement according to claim 6 or 7, by means of which particularly advantageous dynamic connection arrangements can be implemented, as described, for example, in the journal "Akt. Traumatol." 17 (1987), pp. 86-90. With such dynamized connection arrangements, the bone holding rods run preferably perpendicular to the bone axis and lie in one and the same plane. Two connecting rods arranged parallel to each other run parallel to the bone axis and are likewise preferably arranged in a common plane. The joints between the bone holding rods and the connecting rods are designed such that one connecting rod can in each case slip axially guided into the joint of one bone fragment and the other connecting rod into the joint of the other bone holding rod. Thus, the two fragments are held in exact axial alignment on the one hand, whereas a displacement is possible in the axis direction on the other. This guarantees a certain defined flexibility of the connecting device in the stressing of the fracture, whereby the bone healing process is favored.

The advantageous improvement of the invention according to claims 6 and 7 makes possible a dynamized connection arrangement in the sense previously mentioned, in a simple manner. With the provision of two joints arranged at a distance from each other, one of the connecting rods slides in each case in the pair of grooves associated therewith in one joint, but not in the pair of grooves associated therewith of the other joint, and vice versa.

In particular based on the embodiment according to claim 7, it is merely necessary to provide a second type of connecting rods-clamp jaws to implement a dynamization of the connection arrangement, whereby the first type enables a non-positive clamping of both connecting rods on the joint, but, in contrast, the other type enables only the clamping of one connecting rod whereas the other connecting rod can slide axially in the joint with strict axial guidance. The orthopedist or the surgeon can thus selectively produce complete fixation or dynamized fixation of the fracture of a bone as defined above, whereby the capability of placing the individual rotating members at any location on the connecting rods is particularly advantageous because it is thus, for example, possible to replace a connecting rod-clamp jaw clamping both connecting rods to the joint on-site with no problem with another clamp jaw as in claim 6 or 7, if this is considered advantageous, for example, during the course of the bone healing process. The physician thus has available two different, simple to use possibilities for the fixation of a lower leg fracture.

The connection arrangement according to the previously mentioned journal "Akt. Traumatol." 17 (1987) has the disadvantage that the relative axial movement of the two connecting rods can be restricted only by additionally provided stops.

The present invention provides a system in which one connection rods-clamp jaws pair can be used simply as in claim 8, without requiring any adaptive measures whatsoever -- with the exception of a shorter connection bolt.

In order to provide problem-free rotational fixation of the rotating elements of the joint which can rotate relative to each other, the measure according to claim 9 is advantageous, since the radial tooth construction ensures, on the one hand, maintenance of an angular position once set until the connecting bolt is tightened, whereas, on the other, a repositioning of the rotating members by specific predefined angular ranges is possible. An adequate defined adjustment of the rotating members relative to each other is enabled if the individual teeth of the radial tooth construction assume an angle of 2 to 5°, especially roughly 3°. This means, for example, that 120 teeth distributed around the circumference together form the annular tooth construction.

With the spacer disks according to claim 10, which can be available in different thicknesses, additional possibilities for adaptation to differing orthopedic spatial relationships become possible.

The structural design of the connecting arrangement according to the invention takes place expediently according to claims 11 through 14, since, for one thing, a compact

structure of the entire arrangement is thus obtained, whereas, for another, the individual parts can, for example, also be used with no problem in a position offset by 180°, with no resultant dimensional problems.

The invention is described in the following by way of example with reference to the drawings; they depict:

Fig. 1 an axial cross-section of a joint provided in the connecting arrangement according to the invention,

Fig. 2 a top plan view of the joint according to Fig. 1 in the direction of the arrow II in Fig. 1,

Fig. 3 a partially cutaway top plan view of the joint according to Fig. 1 in the direction of the arrow III in Fig. 1,

Fig. 4 a top plan view of a connecting arrangement according to the invention arranged on a bone fracture with a unilateral open substantially flat frame arrangement,

Fig. 5 a view of the object of Fig. 4 in the direction of the arrow V in Fig. 4,

Fig. 6 a view similar to Fig. 4 with a different arrangement of the stops,

Fig. 7 a view of the object of Fig. 6 in the direction of the arrow VII in Fig. 6,

Fig. 8 a view similar to Fig. 4 and 6 with another possible arrangement of the stops,

Fig. 9 a view of the object of Fig. 8 in the direction of the arrow IX in Fig. 8,

Fig. 10 a detailed view similar to Fig. 5, 7, and 9, but with an additional spacer disk provided, and

Fig. 11 a schematic prospective view of the three-dimensional, tentlike connection arrangement according to the invention.

According to Fig. 1 through 3, the joints 17 of an external bone fragment connecting arrangement consist in each case of two substantially circular cylindrical, mutually congruent rotating members 15, 16, which have on their surfaces facing each other in each case identically formed radial tooth constructions 24, which run concentric to the central axis 26 of the rotating members 15, 16.

In the center of the roughly disk-shaped rotating members 15, 16, central connecting bores 20 and 20', respectively, are located, whereby the bore 20' has a slightly smaller diameter than the connection bore 20 and is provided with an inside thread 27. A connecting bolt 19 provided with a head is inserted through the connecting bore 20 from the free face of the rotating member 15 and screwed into the bore 20' provided with an

inside thread to 27 provided on the opposite end, whereby the head of the connecting bolt 19 sits in a recess 28 of the rotating member 15 complementary thereto and thus braces the two rotating members 15, 16 axially against each other and also aligns them axially.

With a somewhat loosened connecting bolt 19, the two rotating members 15, 16 can be rotated around the central axis 26, whereby the click-stop tooth constructions 24 jump in each case from one tooth to the next. By retightening the connecting bolt 19, the angular positions can be fixed once they are set.

According to the invention, the rotating members 15, 16 consist in each case of two clamp jaws 15a, 15b and 16a, 16b, respectively, of which the adjacent clamp jaws 15a and 16a, which are provided with the radial tooth constructions 24, form in the view in Fig. 1 a substantially U-shaped basic part, which are [sic ?is] provided on the surface turned away from the radial tooth construction 24 with a substantially semicircular cylindrical grooves 13a and 14a, respectively.

Into the openings of the clamp jaws 15a and 15b [sic? 16a], respectively, facing away from each other formed as basic parts provided with a substantially U-shaped cross-section, clamp parts forming second clamp jaws 15b and 16b, respectively, which have the flat circular shape discernible in Fig. 2 and 3, are inserted. The clamp jaws 15b, 16b have essentially flat outer faces and are provided axially facing the grooves 13a, 14a with likewise virtually semicircular cylindrical grooves 13b and 14b, respectively, running parallel to the grooves 13a, 14a, by which the circular cylindrical clamping channels discernible in Fig. 1 with the longitudinal axes 21 and 22, respectively, are entirely formed. The connecting bores 20, 20' are realized from corresponding bores in the clamp jaws 15a, 15b, 16a, 16b, whereby the connection bores 20 are provided in the clamp jaws 15a, 15b, 16a; and the threaded bore 20' is provided in the last clamp jaw 16b.

The lower left circular cylindrical clamping channel with the longitudinal axis 22 can also be provided with a somewhat larger slide groove 14a' in the clamp jaw 16a, the purpose of which is described later.

The circular cylindrical clamping channels formed by the grooves 13a, 13b, which, like the clamping channels formed by the grooves 14a, 14b run with their longitudinal axes 21 perpendicular to the central axis 26 of the rotating member 15, 16, serve according to Fig. 4 and 5 to accommodate and clamp two bone holding rods 12, 12' arranged parallel to each other and in one plane, which are screwed into the two fragments 11a, 11b of a bone 11, substantially perpendicular to the longitudinal axis of the bone 11.

The circular cylindrical clamping channels formed by the grooves 14a, 14b with their longitudinal axes 22 have a clearly larger diameter than the clamping channels formed by the grooves 13a, 13b and are used for the substantially positive accommodation of two circular cylindrical connection rods 18, 18' appropriately arranged parallel to each other (Fig. 4, 5). By tightening the connection bolt 19 (Fig. 1, 4, 5), the position of the bone holding rod 12, 12' and the connecting rods 18, 18' according to Fig. 4, 5 can be fixed.

If the embodiment with the somewhat larger slide groove 14a' (Fig. 1) is used, it is necessary that the two clamp jaws 16a, 16b are supported in the region of the slide groove 14a' not only against the connecting rods 18, 18', but also directly against each other at a connection point 23, such that the connecting rod 18 or 18' is held positively at the point in question and axially guided, but not firmly clamped immovably in the axial direction.

In Fig. 4 and 5, the axially movable mounting of the connection rods 18 and 18' in the rotating member 16 is indicated by shading and identified by the reference character 14a'. Thus, according to Fig. 4, at the right joint 17, the upper connecting rod 18 is mounted axially movable in the associated rotating part 16 and, at the left joint 17, the lower connecting rod 18' is mounted axially movable in the associated rotating part 16, whereas the other connecting rod is in each case completely fixedly clamped in the relevant joint 17. In this manner, the two joints 17 can be moved relative to each other in the direction of the double arrow in Fig. 4. In order to restrict the axial movement of the two joints 17 according to Fig. 4 and 5 in the direction of the double arrow, separate rotating members 16 are arranged on the connecting rods 18, 18' to the left near the joints 17 by means of short connecting bolts 19', whereby a defined small distance a between the rotating members 16 and the joints 17 is set. The sum of the two distances a yields the entire longitudinal range of movement of the joints 17 relative to each other in the direction of the double arrow.

In order for the additional rotating members 16 to act as stops, the slide groove 14a' must be provided there in the reverse arrangement from that in the associated joints 17.

The arrangement of the threaded bore 20' (Fig. 1) in the outer clamp jaw 16b of the connecting rods-rotating members 16, thus also has the purpose of enabling the separate use of the rotating members 16 as stops in the sense of Fig. 4, 5 with short connecting bolts 19'.

The manipulation of the connecting arrangement according to the invention is as follows:

First, the bone holding rods 12, 12' according to Fig. 4, 5 are screwed into the fragments 11a, 11b as perpendicularly as possible to the axis of the bone 11. Then, the joints 17 with the connecting rods 18, 18' are installed, and the desired relative position of the two fragments 11a, 11b is then adjusted by observation of an x-ray image of the fracture and fixed by firmly tightening the connecting bolts 19.

If dynamization is to be obtained, it is also possible to provide, from the outset, clamp jaws 16b with the slide groove 14a' on the joints 17 in the arrangement seen in Fig. 4 and 5, whereby the complete fixation of the fracture can also be expediently implemented at the beginning of the healing process in that the distance a in Fig. 4 is set to zero by appropriate movement of the rotating members 16 acting as stops.

Such a design is depicted in Fig. 6 and 7, whereby the separate rotating member 16 acting as a stop is, however, mounted to the right of the joint 17, which is also possible.

Fig. 8 and 9 depict another possible arrangement of the separate rotating members acting as stops compared to Fig. 4, whereby, here, the right rotating member 16 acting as a stop is arranged to the right of the joint 17. The distance a has also been set to zero in the exemplary embodiment according to Fig. 8 and 9, but can be reset at any time by problem-free axial movement of the separate rotating members 16 by the physician.

Fig. 10 shows that, between two rotating members 16, 15, it is also possible to arrange an appropriately dimensioned spacer disk 25, which expediently has on both faces the radial tooth construction 24 by means of which it can engage the two rotating members 15, 16 non-rotatably with each other by clamping with the connecting bolts 19". The spacer disks 25 can be stocked in different thicknesses, whereby the connecting bolt 19" must be designed correspondingly longer than with the exemplary embodiment according to Fig. 1 through 3.

With connecting bolts appropriately designed with different lengths and rotating members 15, 16 and spacer disks 25 variously combined with each other, even very spatially complex connecting arrangements can be realized, whereby an example is depicted perspectively in Fig. 11.

Some of the bone [holding] rods 12, 12' penetrate the fragments 11a, 11b of the bone 11 completely at different levels and lead on opposite sides of the bone 11 in each case into rotating members 15, where they are fixedly clamped according to the invention. The individual rotating members 15 on the opposite sides of the bone 11 are connected to each other by means of the rotating members 16 and the connecting rods 18, 18', whereby, if appropriate, a dynamization according to Fig. 4, 5 can be provided.

Since the left bone holding rods 12, 12' in Fig. 11 are offset in height, two bone rod holder-rotating members 15 are arranged on both sides of a central rotating member 16, for which an appropriately long connecting bolt 19"" must be used. The opposite joint 17 is designed accordingly.

In the exemplary embodiment according to Fig. 11, the bone 11 has a broken-out piece 11c in the center, which can be fixed relative to the fragments 11a, 11b by a bone holding rod 12" drilled-in tent-pole-like from above, whereby the holding of the bone holding rod 12" is effected by connecting rods 18, 18' erected tentlike, which are fixed in the position depicted by means of two connecting rods-rotating members 16 provided on both sides of a central rotating member 15. The connection with the frame located in the plane of the bone 11 is effected by two connecting rod-rotating members 16 constructed together in each case.

The embodiment according to Fig. 11 discloses that the connecting rods-rotating members 16 can be used not only according to Fig. 4 through 9 merely as stops, but also in pairs to connect connecting rods at various angles. Using the spacer disks 25 according to Fig. 10 as an additional structural element, even complex spatial connecting

arrangements can be realized as desired with the connecting arrangement according to the invention.

The two clamp jaws 16a, 16b of the connecting rod-rotating members 16 are preferably designed according to Fig. 1 as components stacked inside each other; however, in principle, two clamp jaws completely symmetrical to each other at the contact level could also be used.

Claims

1. External bone fragment connecting arrangement for mechanical connection of the fragments (11a, [sic 11b,] 11c) of a broken bone (11), in particular of the broken lower leg, with bone holding rods (12, 12', 12'') inserted transversely into the fragments (11a, 11b, 11c), which are clampable outside the bone (11) and the limb containing it between two clamp jaws (15a, 15b) provided with opposing grooves (13a, 13b) complementary to the bone holding rods (12, 12', 12''), which together form the first rotating member (15) of a joint (17), whose second rotating member (16) is fixable in various angular positions relative to the first rotating member (15) by a connecting bolt (19) and is provided with connecting rods (18, 18') for the mechanical connection of a plurality of joints (17), **characterized in** that the second rotating member (16) consists of two clamp jaws (16a, 16b) provided with grooves (14a, 14b) complementary to the connecting rods (18, 18').
2. Arrangement according to claim 1, characterized in that the clamp jaws (15a, 15b; 16a, 16b) consist of a basic part (15a, 16a) with a U-shaped cross-section and a clamping part (15b, 16b) complementary thereto, preferably positively insertable in the opening of the U, whereby the grooves (13a, 14a; 13b, 14b) are located on the bottom of the U and the opposite surface of the clamping part (15b, 16b).
3. Arrangement according to claim 1 or 2, characterized in that the connecting bolt (19) and the bore (20, 20') provided for it run perpendicular to the longitudinal axes (21, 22) of the grooves (13a, 13b; 14a, 14b).
4. Arrangement according to one of the preceding claims, characterized in that the connecting bolt 19 is screwed through a connecting bore (20) in the clamp jaws (15a, 16b; 16a, 16b) into a threaded bore (20') of the last clamp jaw (16b) viewed from the head of the connecting bolt (19).
5. Arrangement according to one of the preceding claims, characterized in that the connecting rods-clamp jaws (16a, 16b) and preferably also the bone holding rods-clamp jaws (15a, 15b) have in each case two pairs of grooves (13a, 13b; 14a, 14b) provided on both sides of the connecting bore (20, 20').
6. Arrangement according to claim 5, characterized in that at least one clamp jaw (16a) of the connecting rods-clamp jaw pairs (16a, 16b) has an enlarged slide groove (14a') and supports itself near the relevant groove (14a') directly (23) on the other clamp jaw (16b) such that the connecting rod (18, 18') inserted in this slide groove (14a') and the corresponding opposite groove (14b) is movable with the tightened connecting bolt (19) axially guided in the rotating member (16).
7. Arrangement according to claim 6, characterized in that only one of the clamp jaws (16a) of the connecting rods-clamp jaws pair (16a, 16b) is designed as described.
8. Arrangement according to claim 6 or 7, characterized in that pure connecting rods-clamp jaws pairs (16a, 16b) can be mounted as stops near the joints (17), which pairs

have at least one slide groove (14a') on that connecting rod (18') with which the associated joint (17) is fixedly clamp.

9. Arrangement according to one of the preceding claims, characterized in that the rotating members (15, 16) have a radial tooth construction (24) on the contacting surfaces concentric to the connecting bore (20, 20') and engage with each other.

10. Arrangement according to one of the preceding claims, characterized in that spacer disks (25) are provided, which have a connecting bore (20") for the connecting bolt (19) and are formed on both faces complementary to the surfaces of the rotating members (15, 16) facing each other.

11. Arrangement according to one of the preceding claims, characterized in that the rotating members (15, 16) and preferably also the spacer disks are designed as circular cylinders.

12. Arrangement according to claim 11, characterized in that the diameter of the rotating members (15, 16) and, possibly, also the spacer disks (25) are the same size.

13. Arrangement according to one of the preceding claims, characterized in that the grooves pairs (13a, 13b; 14a, 14b) of a rotating member (15; 16) are arranged parallel to each other.

14. Arrangement according to one of the preceding claims, characterized in that the groove pairs (13a, 14b; 14a, 14b) of a rotating member (15; 16) are arranged at an equal distance from the central axis (26) of the connecting bores (16, 16').

7 pages of drawings follow

Fig. 1

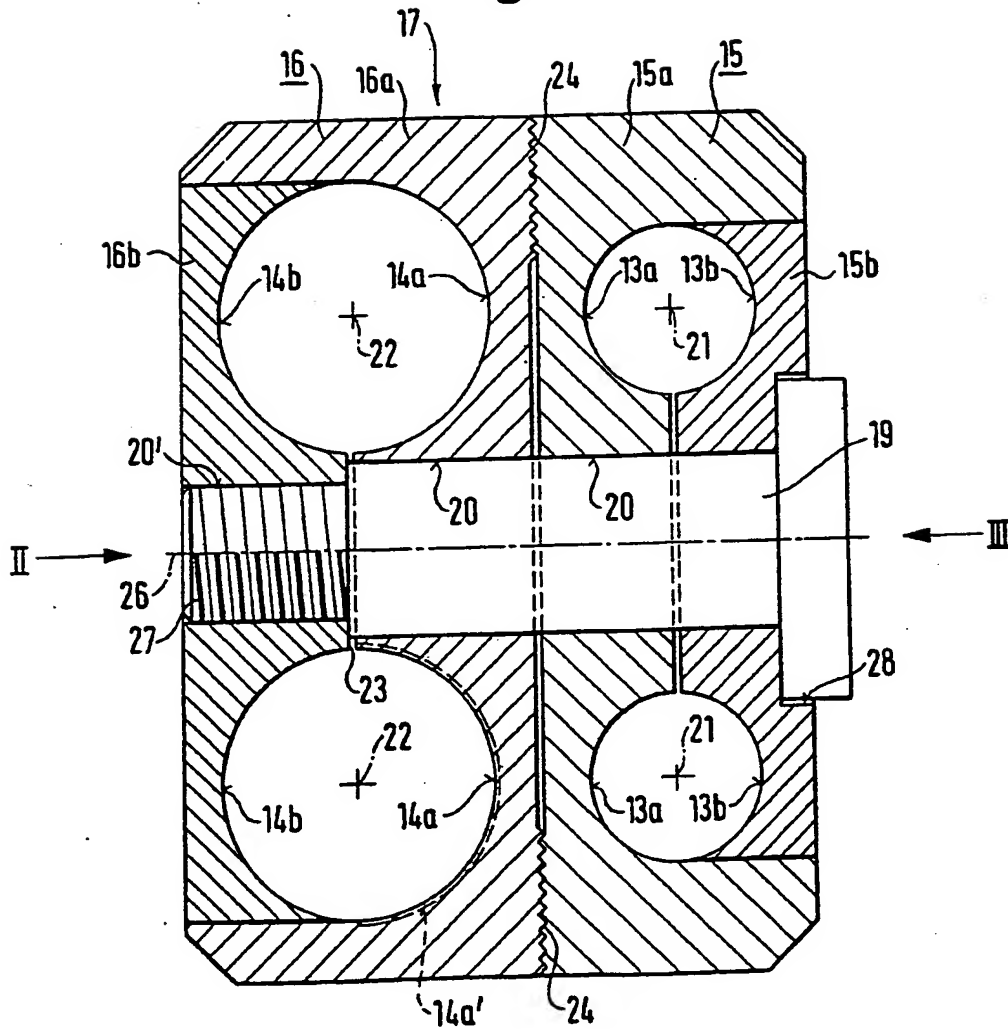


Fig. 2

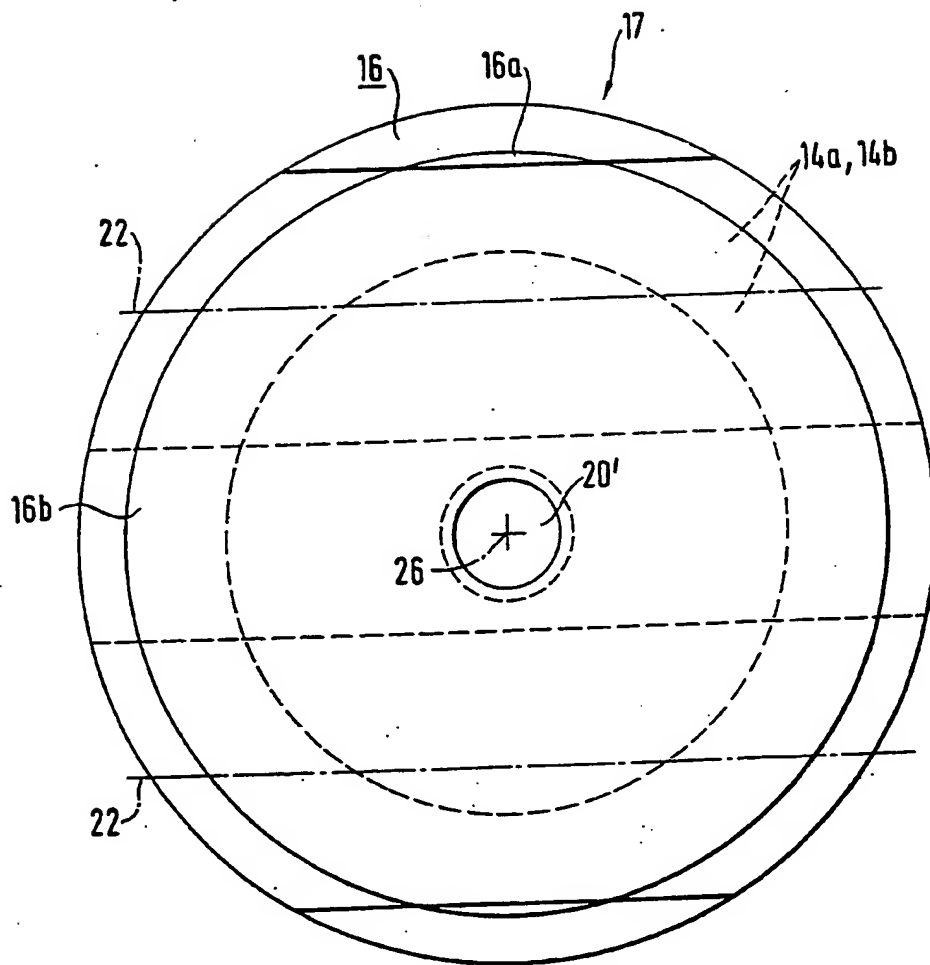


Fig. 3

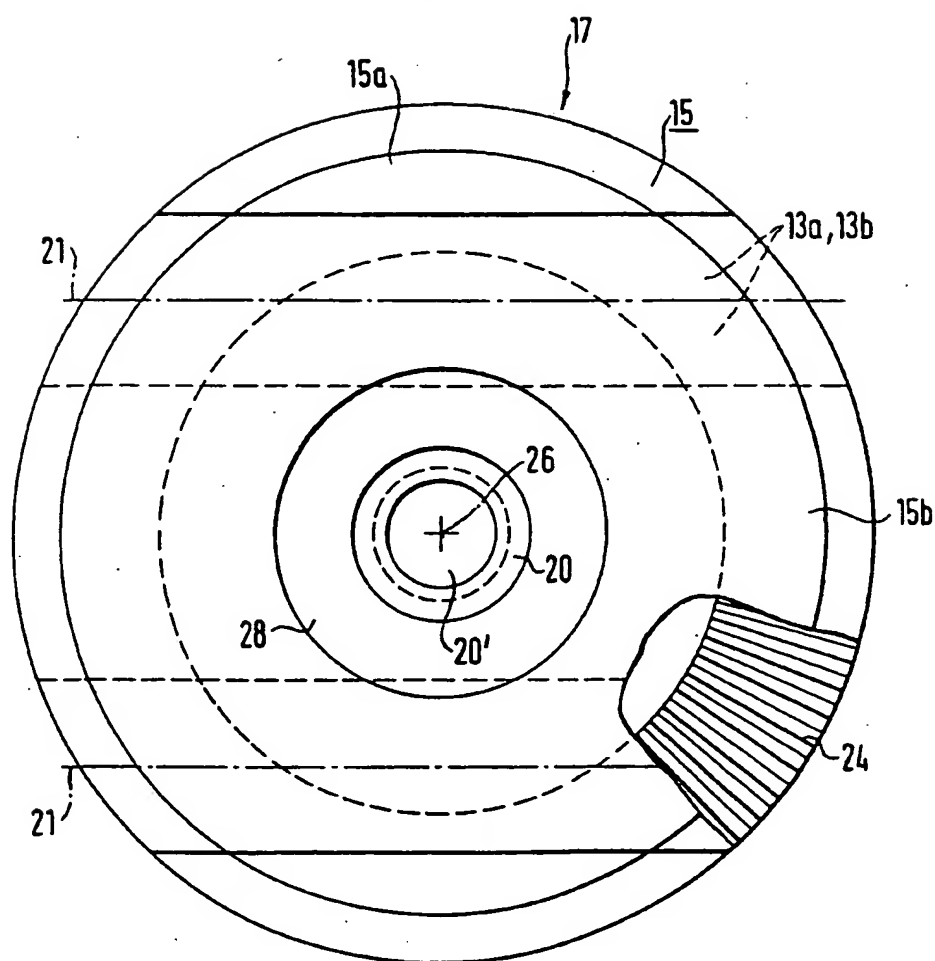


Fig. 4

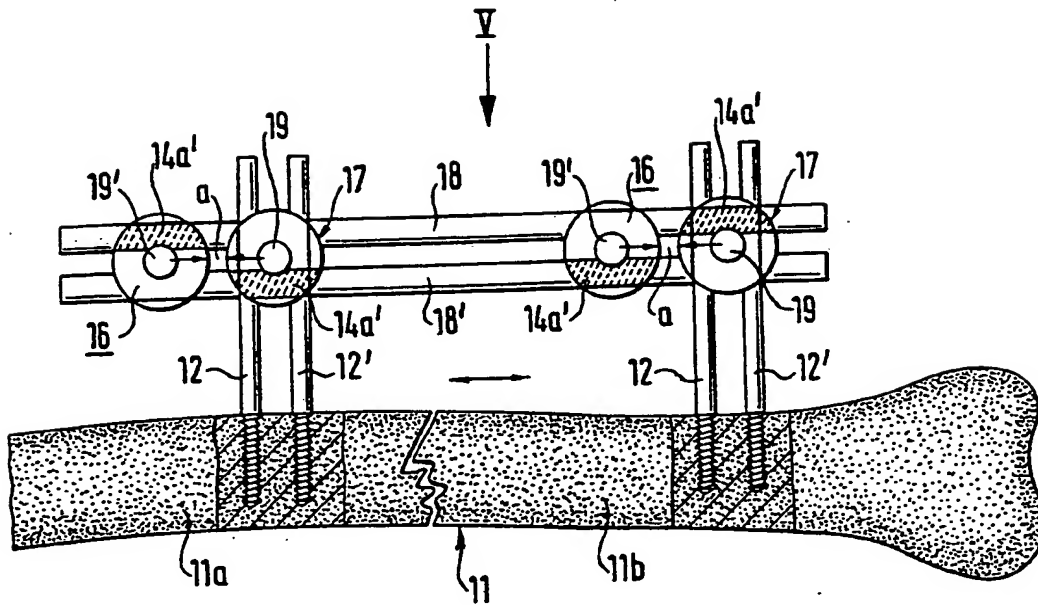


Fig. 5

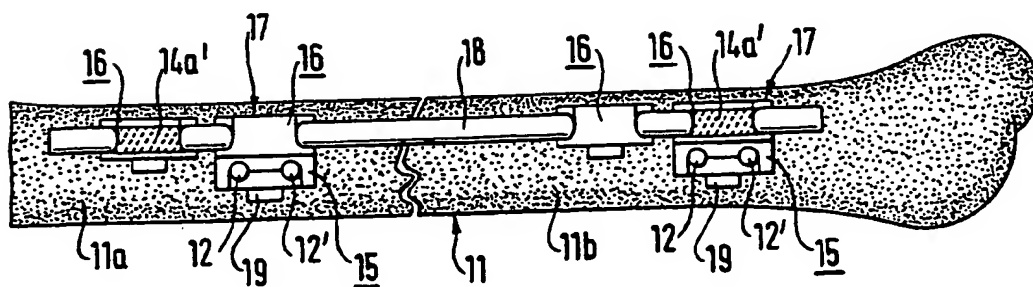


Fig. 6

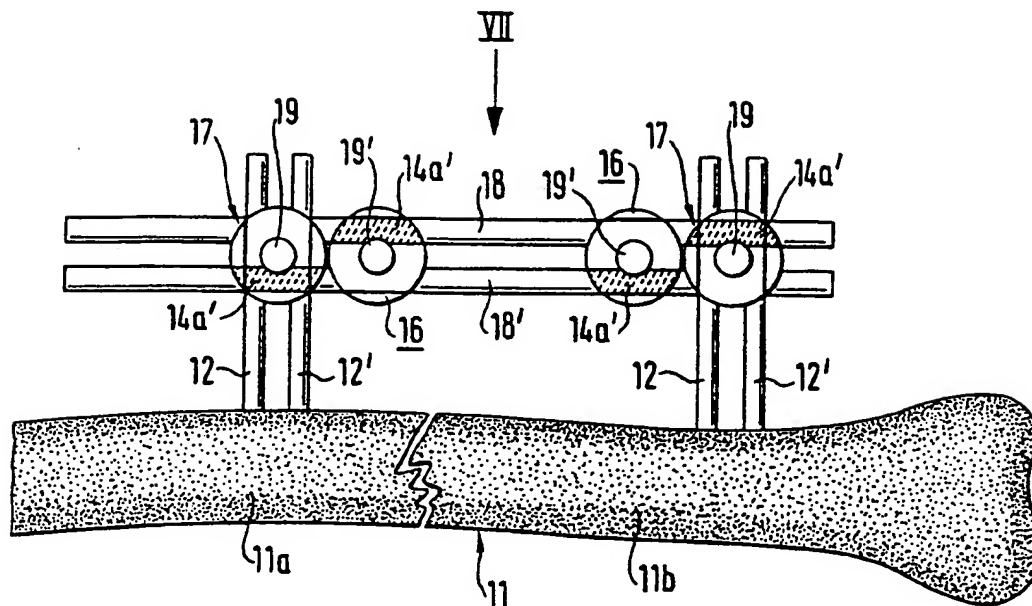


Fig. 7

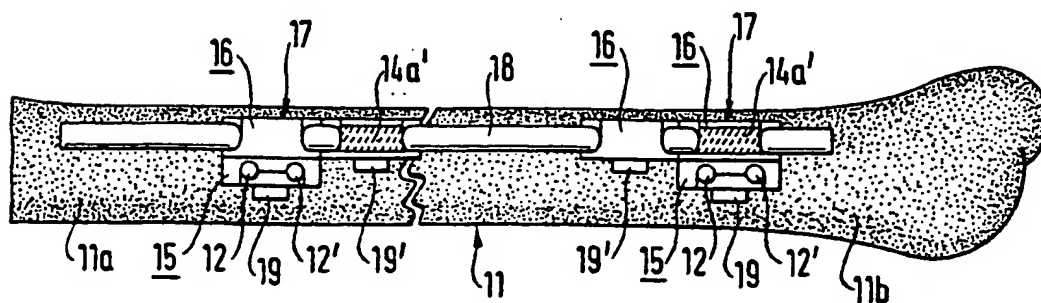


Fig. 8

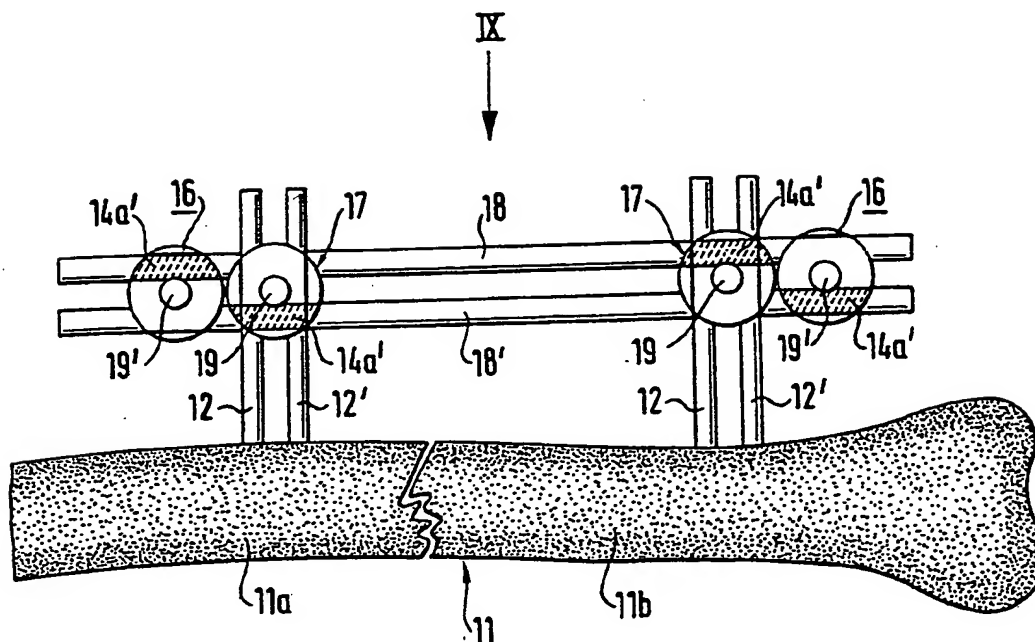
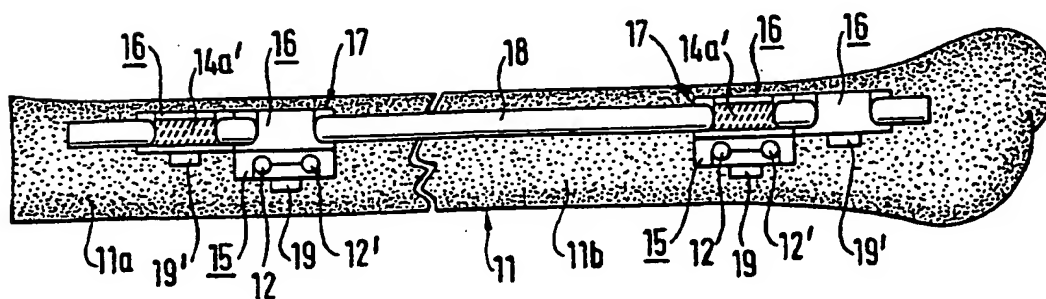
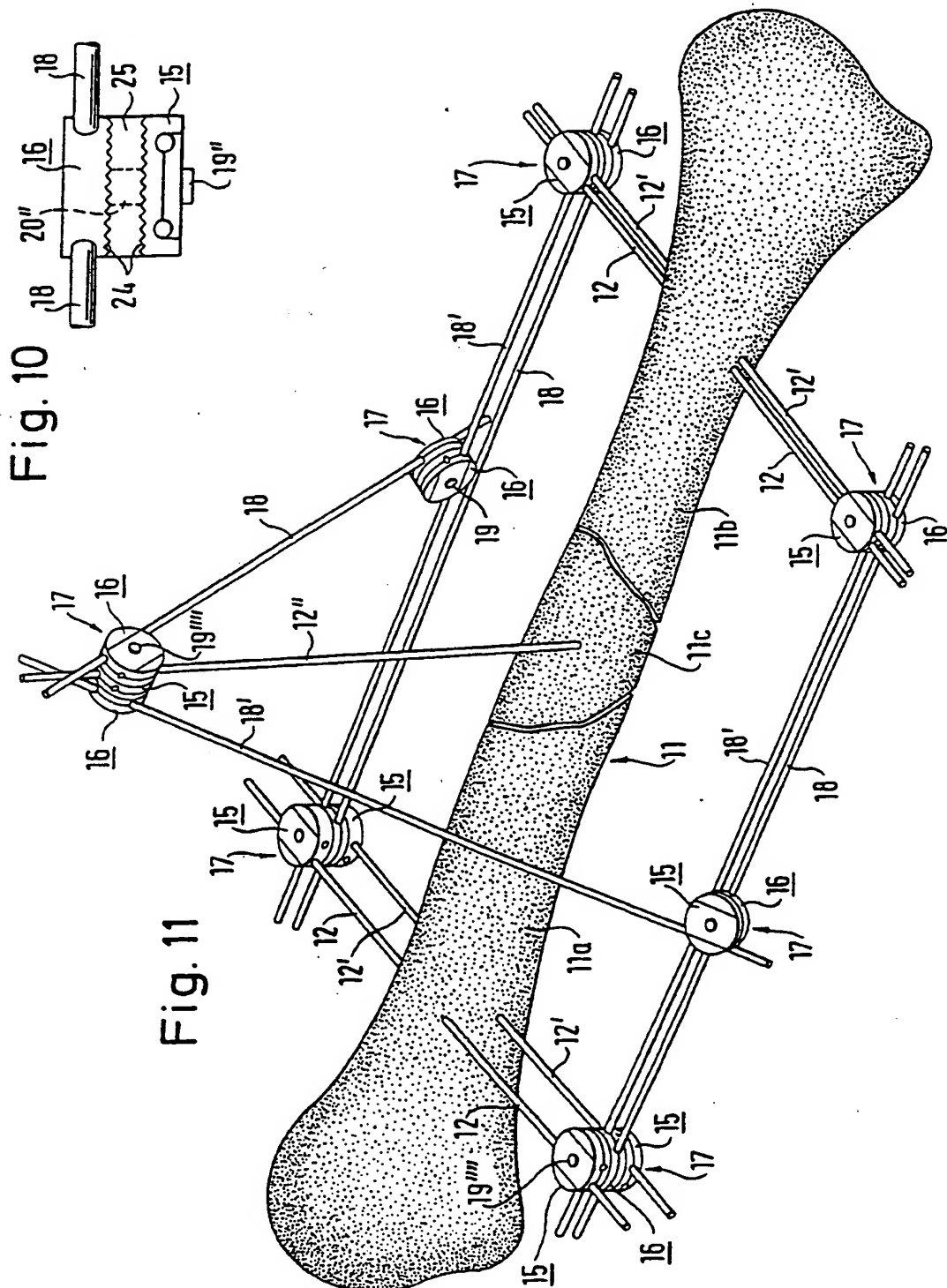


Fig. 9





such an arrangement must be made after the fact between two rotating members already attached at a distance from each other on the connecting rods. The bone fragment connecting arrangement according to the invention is thus particularly universally usable and manipulatable.

Since the joints provided according to the invention consist of at least four clamp jaws plus the connecting bolt, the embodiment according to claim 2 is preferred, since problem-free relative positioning of the clamp jaws in two directions is obtained by means of the engagement of the clamp parts and base parts in each other even before insertion of the connecting bolt through the clamp jaws aligned with each other. The manipulation of the connection arrangement is thus rendered even easier by the measures of claim 2.

By means of the characteristics of claim 3, the rods connected to each other in one plane by a joint can be adjusted at different angles relative to each other.

Although, in principle, even bracing of the clamp jaws against each other by means of a connecting bolt working in conjunction with a nut is possible, the embodiment according to claim 4 is, however, preferred since a separate part, i.e., the nut, is avoided by the arrangement of the threaded bore in the last clamp jaw.

A particular advantage of the invention compared to the prior art mentioned in the introduction consists in that both the bone holding rods and the connecting rods are in contact with the clamp jaws in the entire zone of the preferably half-cylindrical grooves such that a low surface load and a uniform transmission of forces is guaranteed.

The embodiment according to claim 5 is particularly advantageous since with it two bone holding rods or connecting rods combined into a flat arrangement can be arranged on one and the same rotating member, by which means particularly stable frame structures can be created.

The arrangement of two connecting rods parallel to each other in one and the same rotating member enables, however, in particular, the advantageous improvement according to claim 6 or 7, by means of which particularly advantageous dynamic connection arrangements can be implemented, as described, for example, in the journal "Akt. Traumatol." 17 (1987), pp. 86-90. With such dynamized connection arrangements, the bone holding rods run preferably perpendicular to the bone axis and lie in one and the same plane. Two connecting rods arranged parallel to each other run parallel to the bone axis and are likewise preferably arranged in a common plane. The joints between the bone holding rods and the connecting rods are designed such that one connecting rod can in each case slip axially guided into the joint of one bone fragment and the other connecting rod into the joint of the other bone holding rod. Thus, the two fragments are held in exact axial alignment on the one hand, whereas a displacement is possible in the axis direction on the other. This guarantees a certain defined flexibility of the connecting device in the stressing of the fracture, whereby the bone healing process is favored.

The advantageous improvement of the invention according to claims 6 and 7 makes possible a dynamized connection arrangement in the sense previously mentioned, in a simple manner. With the provision of two joints arranged at a distance from each other, one of the connecting rods slides in each case in the pair of grooves associated therewith in one joint, but not in the pair of grooves associated therewith of the other joint, and vice versa.

In particular based on the embodiment according to claim 7, it is merely necessary to provide a second type of connecting rods-clamp jaws to implement a dynamization of the connection arrangement, whereby the first type enables a non-positive clamping of both connecting rods on the joint, but, in contrast, the other type enables only the clamping of one connecting rod whereas the other connecting rod can slide axially in the joint with strict axial guidance. The orthopedist or the surgeon can thus selectively produce complete fixation or dynamized fixation of the fracture of a bone as defined above, whereby the capability of placing the individual rotating members at any location on the connecting rods is particularly advantageous because it is thus, for example, possible to replace a connecting rod-clamp jaw clamping both connecting rods to the joint on-site with no problem with another clamp jaw as in claim 6 or 7, if this is considered advantageous, for example, during the course of the bone healing process. The physician thus has available two different, simple to use possibilities for the fixation of a lower leg fracture.

The connection arrangement according to the previously mentioned journal "Akt. Traumatol." 17 (1987) has the disadvantage that the relative axial movement of the two connecting rods can be restricted only by additionally provided stops.

The present invention provides a system in which one connection rods-clamp jaws pair can be used simply as in claim 8, without requiring any adaptive measures whatsoever -- with the exception of a shorter connection bolt.

In order to provide problem-free rotational fixation of the rotating elements of the joint which can rotate relative to each other, the measure according to claim 9 is advantageous, since the radial tooth construction ensures, on the one hand, maintenance of an angular position once set until the connecting bolt is tightened, whereas, on the other, a repositioning of the rotating members by specific predefined angular ranges is possible. An adequate defined adjustment of the rotating members relative to each other is enabled if the individual teeth of the radial tooth construction assume an angle of 2 to 5°, especially roughly 3°. This means, for example, that 120 teeth distributed around the circumference together form the annular tooth construction.

With the spacer disks according to claim 10, which can be available in different thicknesses, additional possibilities for adaptation to differing orthopedic spatial relationships become possible.

The structural design of the connecting arrangement according to the invention takes place expediently according to claims 11 through 14, since, for one thing, a compact

structure of the entire arrangement is thus obtained, whereas, for another, the individual parts can, for example, also be used with no problem in a position offset by 180°, with no resultant dimensional problems.

The invention is described in the following by way of example with reference to the drawings; they depict:

Fig. 1 an axial cross-section of a joint provided in the connecting arrangement according to the invention,

Fig. 2 a top plan view of the joint according to Fig. 1 in the direction of the arrow II in Fig. 1,

Fig. 3 a partially cutaway top plan view of the joint according to Fig. 1 in the direction of the arrow III in Fig. 1,

Fig. 4 a top plan view of a connecting arrangement according to the invention arranged on a bone fracture with a unilateral open substantially flat frame arrangement,

Fig. 5 a view of the object of Fig. 4 in the direction of the arrow V in Fig. 4,

Fig. 6 a view similar to Fig. 4 with a different arrangement of the stops,

Fig. 7 a view of the object of Fig. 6 in the direction of the arrow VII in Fig. 6,

Fig. 8 a view similar to Fig. 4 and 6 with another possible arrangement of the stops,

Fig. 9 a view of the object of Fig. 8 in the direction of the arrow IX in Fig. 8,

Fig. 10 a detailed view similar to Fig. 5, 7, and 9, but with an additional spacer disk provided, and

Fig. 11 a schematic prospective view of the three-dimensional, tentlike connection arrangement according to the invention.

According to Fig. 1 through 3, the joints 17 of an external bone fragment connecting arrangement consist in each case of two substantially circular cylindrical, mutually congruent rotating members 15, 16, which have on their surfaces facing each other in each case identically formed radial tooth constructions 24, which run concentric to the central axis 26 of the rotating members 15, 16.

In the center of the roughly disk-shaped rotating members 15, 16, central connecting bores 20 and 20', respectively, are located, whereby the bore 20' has a slightly smaller diameter than the connection bore 20 and is provided with an inside thread 27. A connecting bolt 19 provided with a head is inserted through the connecting bore 20 from the free face of the rotating member 15 and screwed into the bore 20' provided with an

inside thread to 27 provided on the opposite end, whereby the head of the connecting bolt 19 sits in a recess 28 of the rotating member 15 complementary thereto and thus braces the two rotating members 15, 16 axially against each other and also aligns them axially.

With a somewhat loosened connecting bolt 19, the two rotating members 15, 16 can be rotated around the central axis 26, whereby the click-stop tooth constructions 24 jump in each case from one tooth to the next. By retightening the connecting bolt 19, the angular positions can be fixed once they are set.

According to the invention, the rotating members 15, 16 consist in each case of two clamp jaws 15a, 15b and 16a, 16b, respectively, of which the adjacent clamp jaws 15a and 16a, which are provided with the radial tooth constructions 24, form in the view in Fig. 1 a substantially U-shaped basic part, which are [sic ?is] provided on the surface turned away from the radial tooth construction 24 with a substantially semicircular cylindrical grooves 13a and 14a, respectively.

Into the openings of the clamp jaws 15a and 15b [sic? 16a], respectively, facing away from each other formed as basic parts provided with a substantially U-shaped cross-section, clamp parts forming second clamp jaws 15b and 16b, respectively, which have the flat circular shape discernible in Fig. 2 and 3, are inserted. The clamp jaws 15b, 16b have essentially flat outer faces and are provided axially facing the grooves 13a, 14a with likewise virtually semicircular cylindrical grooves 13b and 14b, respectively, running parallel to the grooves 13a, 14a, by which the circular cylindrical clamping channels discernible in Fig. 1 with the longitudinal axes 21 and 22, respectively, are entirely formed. The connecting bores 20, 20' are realized from corresponding bores in the clamp jaws 15a, 15b, 16a, 16b, whereby the connection bores 20 are provided in the clamp jaws 15a, 15b, 16a; and the threaded bore 20' is provided in the last clamp jaw 16b.

The lower left circular cylindrical clamping channel with the longitudinal axis 22 can also be provided with a somewhat larger slide groove 14a' in the clamp jaw 16a, the purpose of which is described later.

The circular cylindrical clamping channels formed by the grooves 13a, 13b, which, like the clamping channels formed by the grooves 14a, 14b run with their longitudinal axes 21 perpendicular to the central axis 26 of the rotating member 15, 16, serve according to Fig. 4 and 5 to accommodate and clamp two bone holding rods 12, 12' arranged parallel to each other and in one plane, which are screwed into the two fragments 11a, 11b of a bone 11, substantially perpendicular to the longitudinal axis of the bone 11.

The circular cylindrical clamping channels formed by the grooves 14a, 14b with their longitudinal axes 22 have a clearly larger diameter than the clamping channels formed by the grooves 13a, 13b and are used for the substantially positive accommodation of two circular cylindrical connection rods 18, 18' appropriately arranged parallel to each other (Fig. 4, 5). By tightening the connection bolt 19 (Fig. 1, 4, 5), the position of the bone holding rod 12, 12' and the connecting rods 18, 18' according to Fig. 4, 5 can be fixed.

If the embodiment with the somewhat larger slide groove 14a' (Fig. 1) is used, it is necessary that the two clamp jaws 16a, 16b are supported in the region of the slide groove 14a' not only against the connecting rods 18, 18', but also directly against each other at a connection point 23, such that the connecting rod 18 or 18' is held positively at the point in question and axially guided, but not firmly clamped immovably in the axial direction.

In Fig. 4 and 5, the axially movable mounting of the connection rods 18 and 18' in the rotating member 16 is indicated by shading and identified by the reference character 14a'. Thus, according to Fig. 4, at the right joint 17, the upper connecting rod 18 is mounted axially movable in the associated rotating part 16 and, at the left joint 17, the lower connecting rod 18' is mounted axially movable in the associated rotating part 16, whereas the other connecting rod is in each case completely fixedly clamped in the relevant joint 17. In this manner, the two joints 17 can be moved relative to each other in the direction of the double arrow in Fig. 4. In order to restrict the axial movement of the two joints 17 according to Fig. 4 and 5 in the direction of the double arrow, separate rotating members 16 are arranged on the connecting rods 18, 18' to the left near the joints 17 by means of short connecting bolts 19', whereby a defined small distance a between the rotating members 16 and the joints 17 is set. The sum of the two distances a yields the entire longitudinal range of movement of the joints 17 relative to each other in the direction of the double arrow.

In order for the additional rotating members 16 to act as stops, the slide groove 14a' must be provided there in the reverse arrangement from that in the associated joints 17.

The arrangement of the threaded bore 20' (Fig. 1) in the outer clamp jaw 16b of the connecting rods-rotating members 16, thus also has the purpose of enabling the separate use of the rotating members 16 as stops in the sense of Fig. 4, 5 with short connecting bolts 19'.

The manipulation of the connecting arrangement according to the invention is as follows:

First, the bone holding rods 12, 12' according to Fig. 4, 5 are screwed into the fragments 11a, 11b as perpendicularly as possible to the axis of the bone 11. Then, the joints 17 with the connecting rods 18, 18' are installed, and the desired relative position of the two fragments 11a, 11b is then adjusted by observation of an x-ray image of the fracture and fixed by firmly tightening the connecting bolts 19.

If dynamization is to be obtained, it is also possible to provide, from the outset, clamp jaws 16b with the slide groove 14a' on the joints 17 in the arrangement seen in Fig. 4 and 5, whereby the complete fixation of the fracture can also be expediently implemented at the beginning of the healing process in that the distance a in Fig. 4 is set to zero by appropriate movement of the rotating members 16 acting as stops.

Such a design is depicted in Fig. 6 and 7, whereby the separate rotating member 16 acting as a stop is, however, mounted to the right of the joint 17, which is also possible.

Fig. 8 and 9 depict another possible arrangement of the separate rotating members acting as stops compared to Fig. 4, whereby, here, the right rotating member 16 acting as a stop is arranged to the right of the joint 17. The distance a has also been set to zero in the exemplary embodiment according to Fig. 8 and 9, but can be reset at any time by problem-free axial movement of the separate rotating members 16 by the physician.

Fig. 10 shows that, between two rotating members 16, 15, it is also possible to arrange an appropriately dimensioned spacer disk 25, which expediently has on both faces the radial tooth construction 24 by means of which it can engage the two rotating members 15, 16 non-rotatably with each other by clamping with the connecting bolts 19". The spacer disks 25 can be stocked in different thicknesses, whereby the connecting bolt 19" must be designed correspondingly longer than with the exemplary embodiment according to Fig. 1 through 3.

With connecting bolts appropriately designed with different lengths and rotating members 15, 16 and spacer disks 25 variously combined with each other, even very spatially complex connecting arrangements can be realized, whereby an example is depicted perspectively in Fig. 11.

Some of the bone [holding] rods 12, 12' penetrate the fragments 11a, 11b of the bone 11 completely at different levels and lead on opposite sides of the bone 11 in each case into rotating members 15, where they are fixedly clamped according to the invention. The individual rotating members 15 on the opposite sides of the bone 11 are connected to each other by means of the rotating members 16 and the connecting rods 18, 18', whereby, if appropriate, a dynamization according to Fig. 4, 5 can be provided.

Since the left bone holding rods 12, 12' in Fig. 11 are offset in height, two bone rod holder-rotating members 15 are arranged on both sides of a central rotating member 16, for which an appropriately long connecting bolt 19"" must be used. The opposite joint 17 is designed accordingly.

In the exemplary embodiment according to Fig. 11, the bone 11 has a broken-out piece 11c in the center, which can be fixed relative to the fragments 11a, 11b by a bone holding rod 12" drilled-in tent-pole-like from above, whereby the holding of the bone holding rod 12" is effected by connecting rods 18, 18' erected tentlike, which are fixed in the position depicted by means of two connecting rods-rotating members 16 provided on both sides of a central rotating member 15. The connection with the frame located in the plane of the bone 11 is effected by two connecting rod-rotating members 16 constructed together in each case.

The embodiment according to Fig. 11 discloses that the connecting rods-rotating members 16 can be used not only according to Fig. 4 through 9 merely as stops, but also in pairs to connect connecting rods at various angles. Using the spacer disks 25 according to Fig. 10 as an additional structural element, even complex spatial connecting

arrangements can be realized as desired with the connecting arrangement according to the invention.

The two clamp jaws 16a, 16b of the connecting rod-rotating members 16 are preferably designed according to Fig. 1 as components stacked inside each other; however, in principle, two clamp jaws completely symmetrical to each other at the contact level could also be used.

Claims

1. External bone fragment connecting arrangement for mechanical connection of the fragments (11a, [sic 11b,] 11c) of a broken bone (11), in particular of the broken lower leg, with bone holding rods (12, 12', 12'') inserted transversely into the fragments (11a, 11b, 11c), which are clampable outside the bone (11) and the limb containing it between two clamp jaws (15a, 15b) provided with opposing grooves (13a, 13b) complementary to the bone holding rods (12, 12', 12''), which together form the first rotating member (15) of a joint (17), whose second rotating member (16) is fixable in various angular positions relative to the first rotating member (15) by a connecting bolt (19) and is provided with connecting rods (18, 18') for the mechanical connection of a plurality of joints (17), **characterized in** that the second rotating member (16) consists of two clamp jaws (16a, 16b) provided with grooves (14a, 14b) complementary to the connecting rods (18, 18').

2. Arrangement according to claim 1, characterized in that the clamp jaws (15a, 15b; 16a, 16b) consist of a basic part (15a, 16a) with a U-shaped cross-section and a clamping part (15b, 16b) complementary thereto, preferably positively insertable in the opening of the U, whereby the grooves (13a, 14a; 13b, 14b) are located on the bottom of the U and the opposite surface of the clamping part (15b, 16b).

3. Arrangement according to claim 1 or 2, characterized in that the connecting bolt (19) and the bore (20, 20') provided for it run perpendicular to the longitudinal axes (21, 22) of the grooves (13a, 13b; 14a, 14b).

4. Arrangement according to one of the preceding claims, characterized in that the connecting bolt 19 is screwed through a connecting bore (20) in the clamp jaws (15a, 16b; 16a, 16b) into a threaded bore (20') of the last clamp jaw (16b) viewed from the head of the connecting bolt (19).

5. Arrangement according to one of the preceding claims, characterized in that the connecting rods-clamp jaws (16a, 16b) and preferably also the bone holding rods-clamp jaws (15a, 15b) have in each case two pairs of grooves (13a, 13b; 14a, 14b) provided on both sides of the connecting bore (20, 20').

6. Arrangement according to claim 5, characterized in that at least one clamp jaw (16a) of the connecting rods-clamp jaw pairs (16a, 16b) has an enlarged slide groove (14a') and supports itself near the relevant groove (14a') directly (23) on the other clamp jaw (16b) such that the connecting rod (18, 18') inserted in this slide groove (14a') and the corresponding opposite groove (14b) is movable with the tightened connecting bolt (19) axially guided in the rotating member (16).

7. Arrangement according to claim 6, characterized in that only one of the clamp jaws (16a) of the connecting rods-clamp jaws pair (16a, 16b) is designed as described.

8. Arrangement according to claim 6 or 7, characterized in that pure connecting rods-clamp jaws pairs (16a, 16b) can be mounted as stops near the joints (17), which pairs

have at least one slide groove (14a') on that connecting rod (18') with which the associated joint (17) is fixedly clamp.

9. Arrangement according to one of the preceding claims, characterized in that the rotating members (15, 16) have a radial tooth construction (24) on the contacting surfaces concentric to the connecting bore (20, 20') and engage with each other.

10. Arrangement according to one of the preceding claims, characterized in that spacer disks (25) are provided, which have a connecting bore (20") for the connecting bolt (19) and are formed on both faces complementary to the surfaces of the rotating members (15, 16) facing each other.

11. Arrangement according to one of the preceding claims, characterized in that the rotating members (15, 16) and preferably also the spacer disks are designed as circular cylinders.

12. Arrangement according to claim 11, characterized in that the diameter of the rotating members (15, 16) and, possibly, also the spacer disks (25) are the same size.

13. Arrangement according to one of the preceding claims, characterized in that the grooves pairs (13a, 13b; 14a, 14b) of a rotating member (15; 16) are arranged parallel to each other.

14. Arrangement according to one of the preceding claims, characterized in that the groove pairs (13a, 14b; 14a, 14b) of a rotating member (15; 16) are arranged at an equal distance from the central axis (26) of the connecting bores (16, 16').

7 pages of drawings follow

Fig. 1

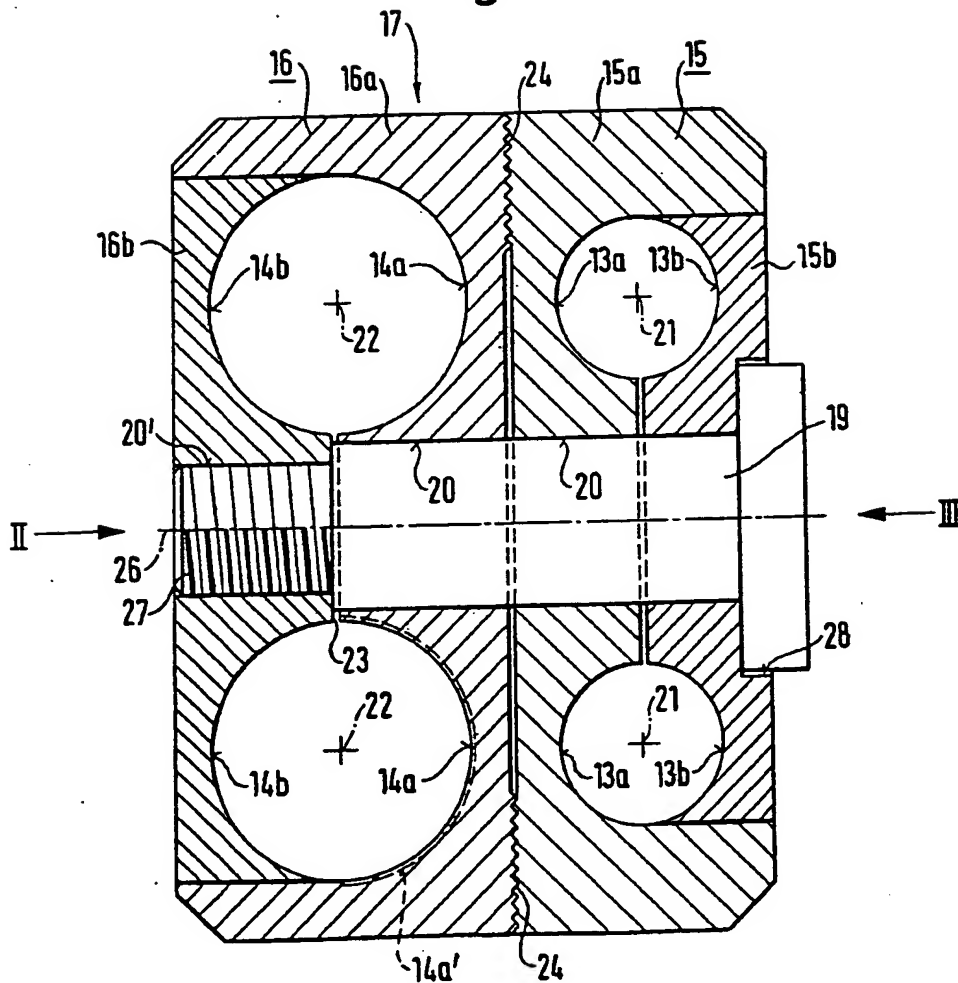


Fig. 2

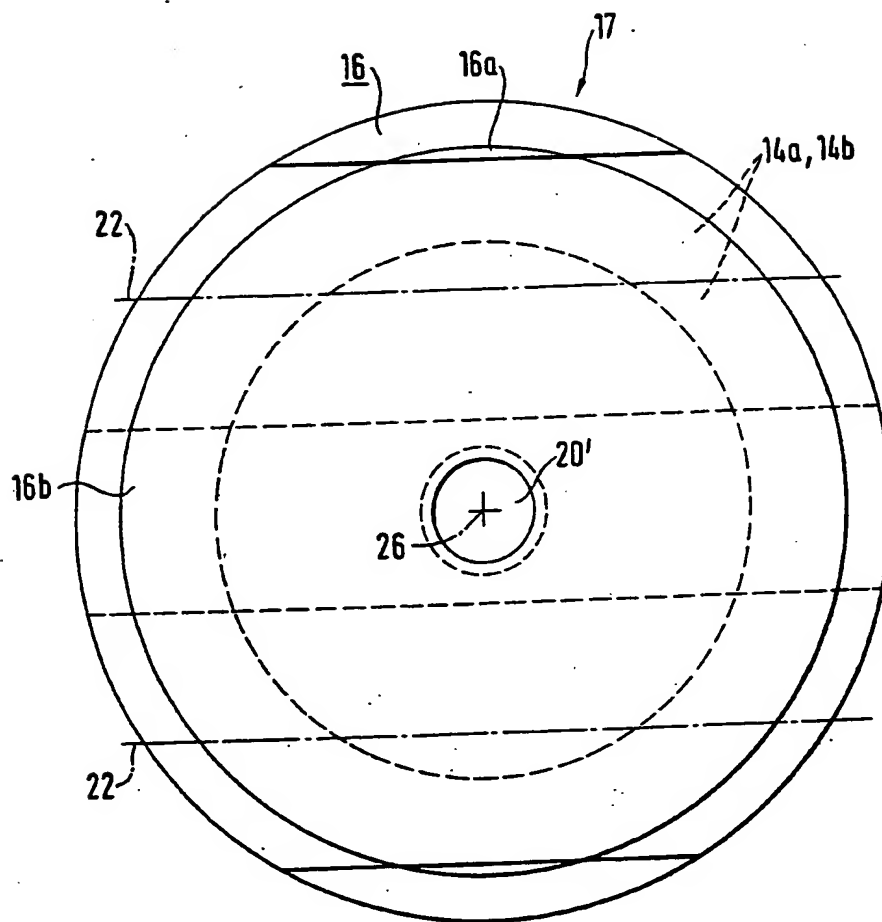


Fig. 3

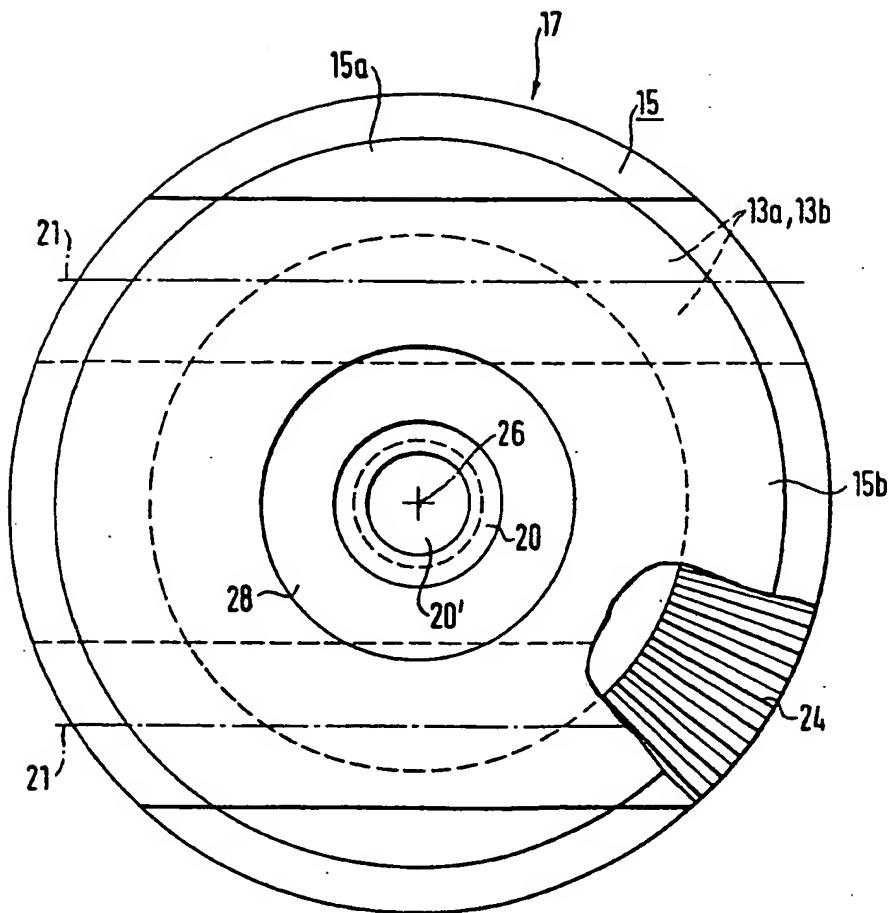


Fig. 4

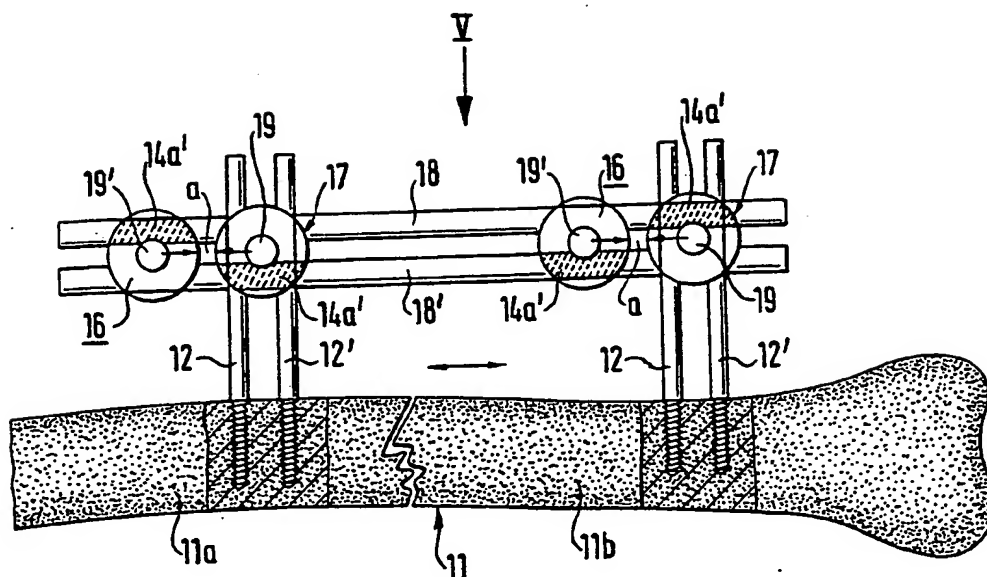


Fig. 5

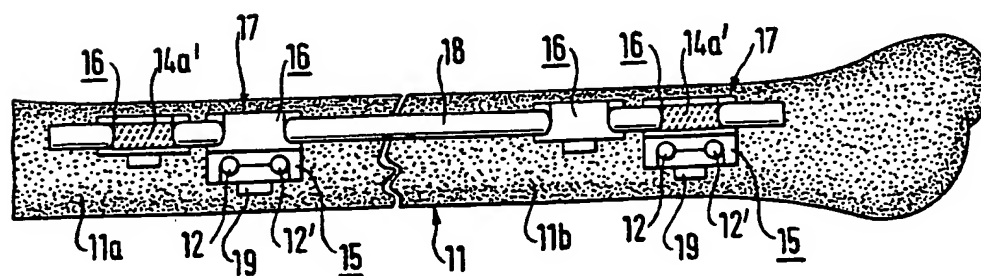


Fig. 6

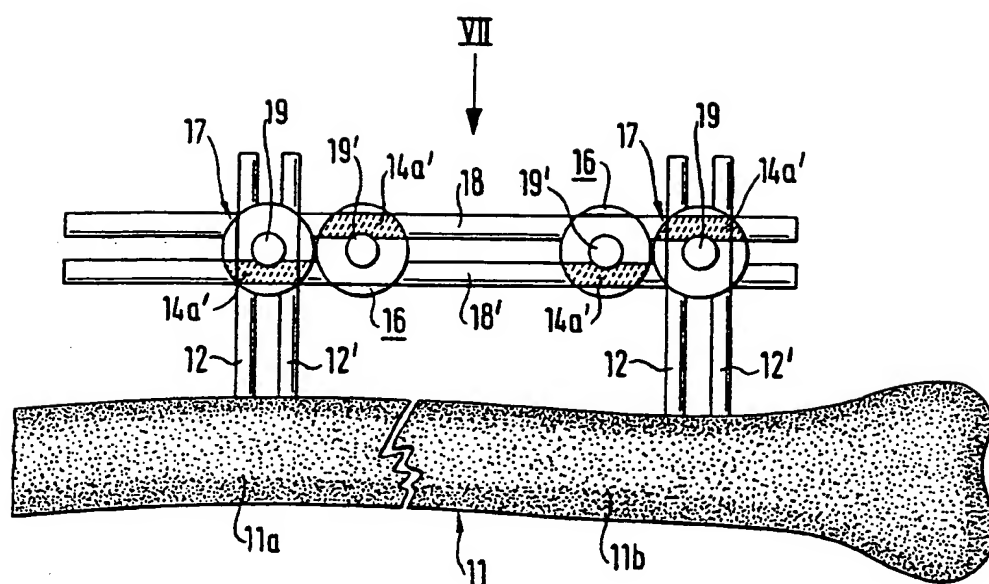


Fig. 7

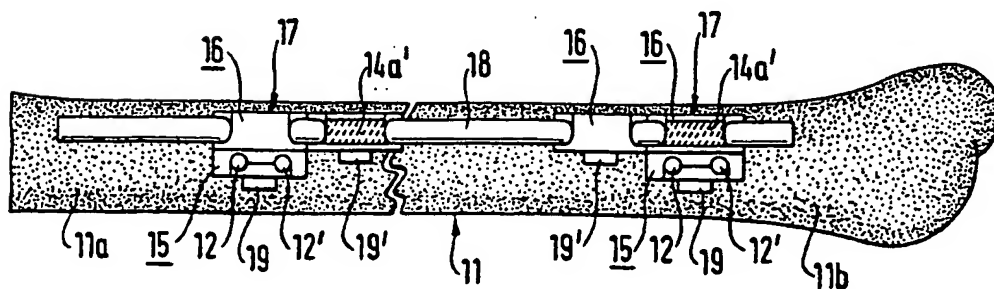


Fig. 8

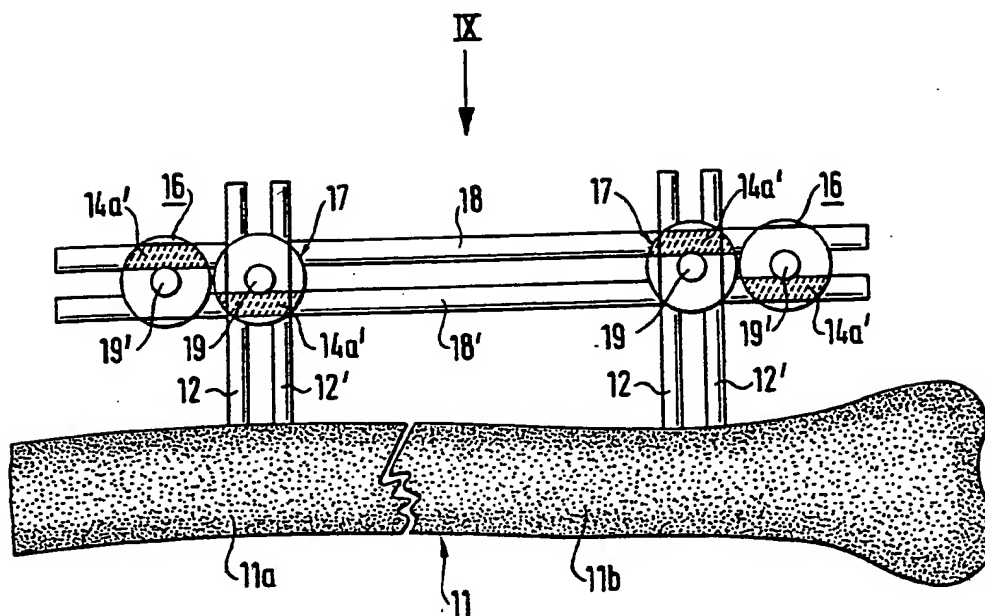


Fig. 9

